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ABSTRACT

Project AIMS (Activities to Integrate Mathematics and Science) has as its purpose the integration of subject matter in grades K-9. Field testing of the curriculum materials produced by AIMS indicates that this interpretation produces the following beneficial results: (1) mathematics becomes more meaningful, hence more useful; (2) science is increasingly studied and understood, with a significant economy of time; (3) there is improved quality of learning and retention; and (4) there is a dramatic increase in students' motivation and involvement. This teaching guide to physics for grades K-3 contains 31 lessons, each with a teaching instructions page with lists of materials, objectives and procedures, and reproducible worksheets for students. Topics include: (1) sound energy; (2) light energy; and (3) heat energy and temperature. Also included is a glossary, a checklist of science processes and math skills, a list of children's literature which may be used to extend these lessons, a list of materials for the unit, and information on the AIMS project. (CW)

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Primarily Physics

Investigations in Sound, Light & Heat Energy

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PROJECT AIMS K–3

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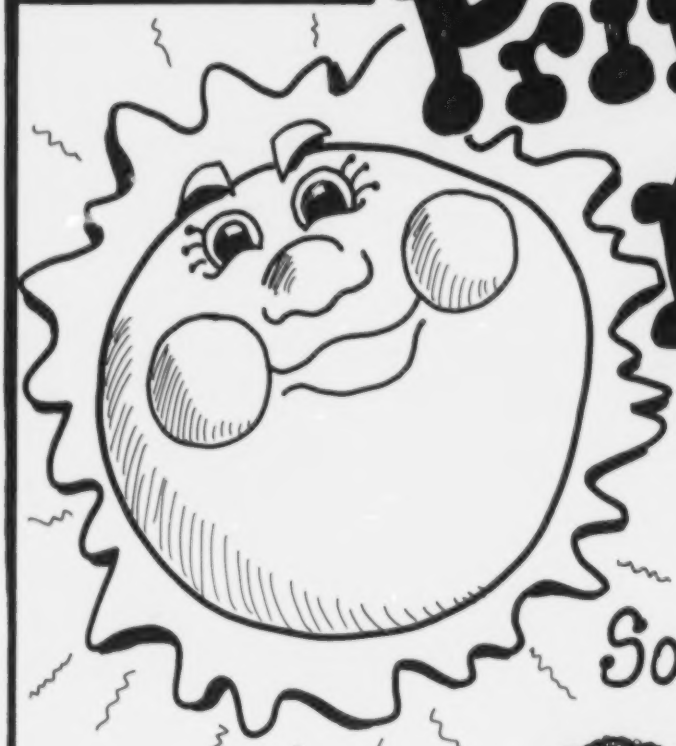

Investigations in Sound, Light & Heat Energy

PROJECT AIMS

Grades K–3

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who willingly shared many creative ideas.

Primarily Physics

INVESTIGATIONS IN SOUND, LIGHT AND HEAT FOR K-3

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Primarily Physics has been developed through a cooperative program involving the AIMS Education Foundation and Fresno Unified School District.

Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

Project AIMS Publications

GRADES 5–9 SERIES

Math + Science, A Solution

The Sky's the Limit

From Head to Toe

Fun With Foods

Floaters and Sinkers

Down to Earth

Our Wonderful World

Pieces and Patterns, A Patchwork in Math and Science

Piezas y Diseños, un Mosaic de MATEMÁTICAS y CIENCIAS

Out of This World, Book A

Soap Films and Bubbles (4-9)

Finding Your Bearings

GRADES K–4 SERIES

Fall Into Math and Science

Cáete de gusto hacia el OTOÑO con las MATHEMÁTICAS y CIENCIAS

Glide Into Winter With Math and Science

Patine Al INVIERNO con MATEMÁTICAS y CIENCIAS

Spring Into Math and Science

Brinca de alegria hacia la PRIMAVERA con las MATEMÁTICAS y CIENCIAS

Seasoning Math and Science, Book A (Fall and Winter)

Seasoning Math and Science, Book B (Spring and Summer)

Jawbreakers and Heartthumpers

Hardhatting in a Geo-World

Popping With Power

Overhead and Underfoot

Primarily Plants

Primarily Physics

GRADES K–6

Primarily Bears, Book 1

Water Precious Water, Book A

Critters

Mostly Magnets

FOR FURTHER INFORMATION WRITE TO:

AIMS Education Foundation • P.O. Box 8120 • Fresno, California 93747

I HEAR, AND I FORGET
I SEE; AND I REMEMBER
I DO, AND I UNDERSTAND.

-Chinese Proverb

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Science Processes

	Observing	Communicating	Collecting/Recording Data	Predicting	Classifying	Drawing Conclusions	Interpreting Data
Sound is Vibration	✓	✓	✓	✓		✓	✓
Traveling Sounds	✓	✓		✓		✓	
Paper Cup Telephone	✓	✓					
Musical Bottles	✓	✓	✓	✓		✓	
Sound of Voices	✓	✓		✓			
Eggs—Full of Sound	✓	✓	✓	✓		✓	
Big Ears	✓	✓		✓		✓	
Which Way?	✓	✓	✓	✓		✓	✓
Musical Instruments	✓	✓	✓		✓		
The Eyes	✓	✓	✓			✓	
Light Sources	✓	✓			✓		
Mirrors Reflect	✓	✓	✓	✓		✓	✓
Just Passing Through	✓	✓	✓	✓	✓		
Light Rays Slow Down	✓	✓	✓			✓	
I ♥ Color	✓	✓	✓	✓			
Magnify	✓	✓					
Prism Power	✓	✓		✓		✓	
What is Hot and What is Cold?	✓	✓	✓		✓		
Heat From Friction	✓	✓					
Hot or Cold?	✓	✓		✓		✓	✓
What is the Temperature?	✓	✓	✓				✓
Melt an Ice Cube	✓	✓	✓	✓			
Heat and Color	✓	✓	✓			✓	✓
When Hot and Cold Meet	✓	✓	✓	✓		✓	
Heat Moves	✓	✓	✓	✓	✓	✓	
Heat Travels	✓	✓				✓	
Cold Tin and Hot Hands	✓	✓	✓			✓	

Math Skills

	Measuring	Comparing	Graphing	Estimating	Problem Solving	Timing	Basic Computation ASMD
Sound is Vibration		✓			✓		
Traveling Sounds		✓		✓	✓		
Paper Cup Telephone	✓	✓					✓
Musical Bottles	✓	✓	✓	✓			
Sound of Voices		✓					
Eggs—Full of Sound		✓		✓	✓		✓
Big Ears		✓					
Which Way?		✓		✓	✓		
Musical Instruments	✓	✓		✓	✓		
The Eyes	✓	✓					
Light Sources		✓			✓		
Mirrors Reflect		✓			✓		
Just Passing Through	✓	✓		✓			
Light Rays Slow Down	✓	✓			✓		
I ♥ Color		✓	✓	✓			
Magnify		✓					
Prism Power		✓		✓			
What is Hot and What is Cold?	✓	✓			✓		
Heat From Friction		✓					
Hot or Cold?	✓	✓				✓	
What is the Temperature?	✓	✓	✓			✓	
Melt an Ice Cube	✓	✓	✓	✓	✓	✓	✓
Heat and Color	✓	✓	✓		✓	✓	
When Hot and Cold Meet		✓					
Heat Moves	✓	✓					
Heat Travels							
Cold Tin and Hot Hands		✓					

Standard and Expanded AIMS Duplication Programs

It is the goal of the AIMS Education Foundation to make its materials and programs available to schools and educators at reasonable cost consistent with the maintenance of high standards of quality.

The support for continued research, development, field-testing, and publication of AIMS materials is dependent entirely on the revenue produced from the sales of books, posters, the AIMS Newsletter, and other publications of the Foundation.

It is, therefore, of utmost importance that all educators and educational agencies carefully observe the generous privileges and applicable restrictions for duplication.

Two broad types of duplication privileges are offered: standard and expanded. Within the expanded duplication program Class I and Class II contracts are available. Each of these is defined in detail below.

Standard Duplication Privileges

A school or individual purchasing any AIMS publication is granted the right to make up to 200 copies of any of the materials therein for use by teachers at that school site.

Workshop leaders may make up to 200 copies in the same manner as schools. Teachers receiving copies from workshop leaders may duplicate no more than 35 copies of student pages received in a workshop or enough to use the lessons one time with one class. Any further duplication without the purchase of the materials is strictly forbidden.

All educators conducting AIMS workshops are expected to explain the Model of Mathematics and Model of Learning and consistently refer to it as activities are presented since these Models are the basis on which the AIMS program rests. Such understanding is essential to achieve the highest possible benefit from AIMS.

If an educational agency publishes a newsletter or similar publications for distribution to multiple sites, no more than 200 copies of any AIMS materials included therein may be made without written permission from the AIMS Education Foundation. Further, such multiple-site newsletters may duplicate no more than one science activity and one mathematics activity from any one issue of the AIMS Newsletter or book.

Whenever AIMS materials are duplicated in any form the AIMS Education Foundation copyright must appear. In the case of newsletters or similar publications information regarding the availability of AIMS publications and the fact that they may be ordered from the Foundation must be noted.

Extended Duplication Contracts

The AIMS Education Foundation has approved programs whereby schools, school districts, and other non-profit educational agencies may purchase additional duplication rights. These programs are particularly appropriate for districts who wish to publish AIMS materials in a central office for district-wide use or to publish more than the 200-copy limit which comes with the purchase of a book.

Two classes of rights are available:

A Class I contract provides for the purchase of the right to duplicate an additional 250 copies beyond the 200-copy limit that accompanies the purchase of a book; and,

A Class II contract permits the duplication of an unlimited number of copies for use at given school sites. **A special provision of this contract extends this duplication right to revised editions of any of the books covered.**

Both Class I and Class II contracts are based on the **book/site unit.**

A book/site unit consists of duplication rights for one book for use at one school site.

The Class I contract price is $10.00 per book/site unit.

The Class II contract price is $20.00 per book/site unit.

Examples of Contract Elements and Costs

District A wishes to purchase Class I duplication rights for 8 books to be used in 6 of its schools. The cost is computed as followed:

8 books x 6 sites x $10.00 = $480.00

District B wishes to purchase Class II duplication rights for 16 books at 10 sites. The cost is computed as follows:

16 books x 10 sites x $20.00 = $3200.00

A purchase order submitted to the AIMS Education Foundation needs to clearly specify each of the following:

1. The titles of all of the books involved.
2. The number of sites for which duplication rights are being purchased.
3. The class of contract that is requested.

The AIMS Education Foundation will complete the contract authorizing the requested duplication rights and remit it to the contracting educational agency.

Address all correspondence and purchase order to:

AIMS Education Foundation
P.O. Box 8120
Fresno, California 93747

AIMS Newsletter Subscription Information

Each issue of the AIMS Newsletter contains a wealth of resources consisting of new AIMS integrated mathematics/ science investigations, simple science experiments, and problem solving mathematics activities.

The AIMS Newsletter is published monthly, August through May. Subscriptions are on an annual basis only. A subscription entered at any time will receive the 10 issues for that year beginning with the previous August issue. This format is used since many of the articles in an annual volume are interrelated and all need to be available for maximum benefit.

The average issue of an AIMS Newsletter contains four or more new AIMS investigations, at least one each at the K–1, 2–4, and 5–9 grade levels; one 8.5 x 11 inch blackline master poster describing a simple science experiment; two 8.5 x 11 inch blackline master posters displaying problem solving situations; information about developments in the AIMS program, workshops, courses, and other activities; feature articles of lasting value dealing with science instruction, problem solving in mathematics, etc.; a description of how a school, district, or state is implementing AIMS in a systemmatic manner; activities by members of the AIMS National Leadership Network and the writing teams; a thorough preview of all new AIMS and SETUP publications; information about conference presentations by the program directors of AIMS where participants can meet with them personally; and a periodic listing of all AIMS publications.

The problem solving poster series in the Newsletter is accompanied by a thorough analysis of problem solving approaches appropriate to each situation. This analysis serves as an aid to classroom teachers who wish to enhance their own knowledge of problem solving and help students acquire an inventory of problem solving skills. Authored by Wilbert Reimer and Arthur Wiebe, both of whom studied extensively under Dr. George Polya at Stanford University, both series reflect his influence.

The ten issues in the annual volume contain forty or more new AIMS investigations, ten science posters, and twenty problem solving challenges, plus numerous articles dealing with the teaching of "hands-on" science, evaluating higher order thinking skills and student progress in mastering process skills, and other enriching resources.

Since duplication rights for one school site are granted for all materials published in the Newsletter, it is highly cost effective for a school to enter a subscription and build a library for the use of all of its teachers.

The annual subscription price is $22.50. Volumes I and II are still available.

AIMS Newsletter Subscription

Subscriptions are accepted on an annual basis only. Subscriptions entered at any time during the year receive all issues of that year, August – May.

Please indicate quantity:

____ Volume I issues 1986–87
____ Volume II issues 1987–88
____ Volume III issues 1988–89
____ Volume IV subscription 1989–90
____ Volume V subscription 1990–91

Order any one volume for $22.50, each additional volume on this order is $20.00.

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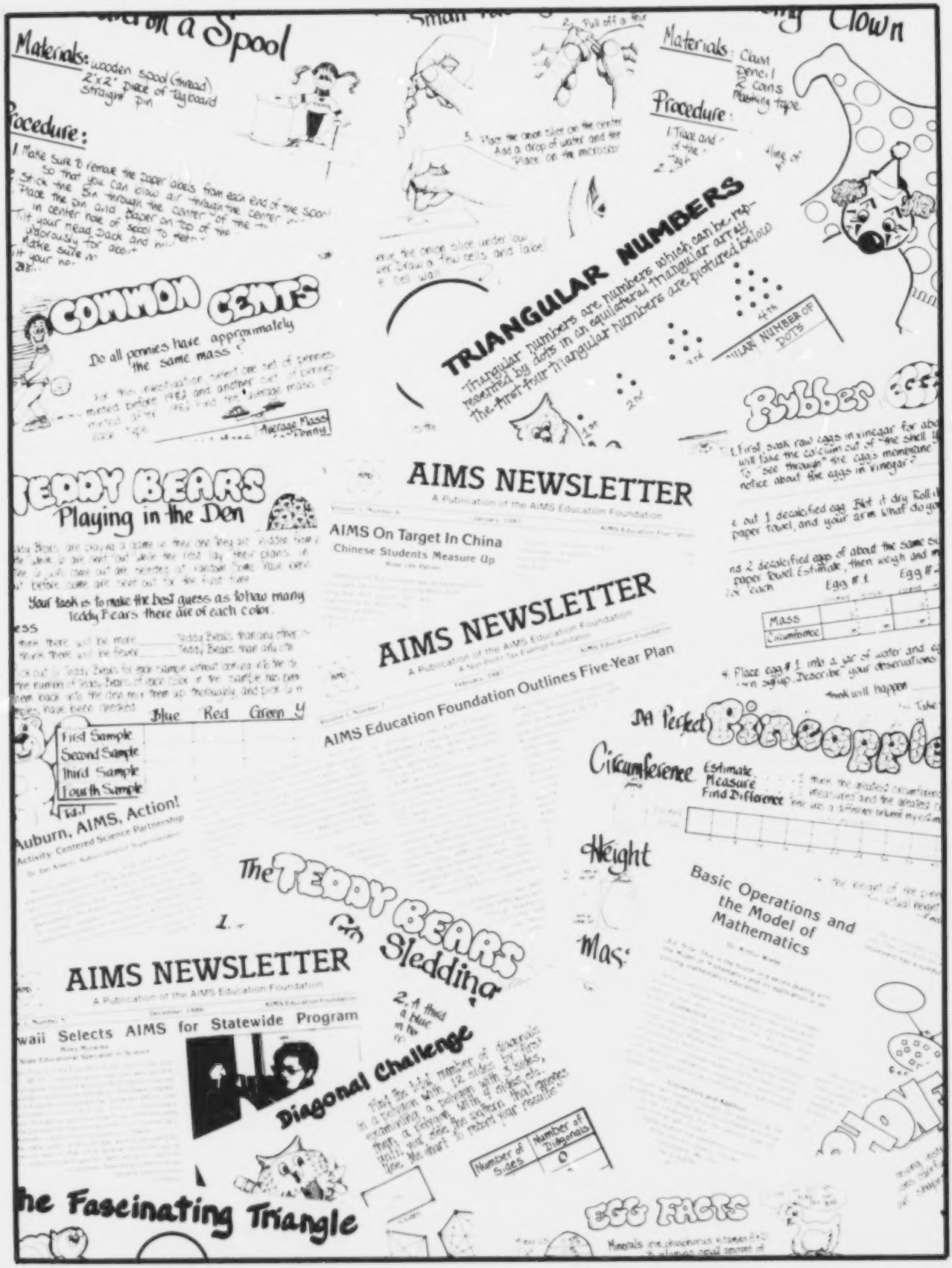

Materials:
Procedure:
COMMON CENTS
Do all pennies have approximately the same mass?
TRIANGULAR NUMBERS
Triangular numbers are numbers which can be represented by dots in an equilateral triangular array. The first four triangular numbers are pictured below.
Clown
Bubbles
AIMS NEWSLETTER
A Publication of the AIMS Education Foundation
AIMS On Target In China
Chinese Students Measure Up
AIMS NEWSLETTER
AIMS Education Foundation Outlines Five-Year Plan
TEDDY BEARS
Playing in the Den
Your task is to make the best guess as to how many teddy bears there are of each color.
Blue Red Green Y
First Sample
Second Sample
Third Sample
Fourth Sample
Auburn, AIMS, Action!
Activity-Centered Science Partnership
A Perfect Pineapple
Circumference
Estimate
Measure
Find Difference
Height
Basic Operations and the Model of Mathematics
The TEDDY BEARS Go Sledding
AIMS NEWSLETTER
A Publication of the AIMS Education Foundation
Hawaii Selects AIMS for Statewide Program
Diagonal Challenge
Number of Sides
Number of Diagonals
The Fascinating Triangle
EGG FACTS

AIMS Education Foundation Programs

The AIMS Education Foundation sponsors a variety of programs and services. Write for additional current information about any of these:

AIMS National Leadership Program in Math/Science

The Leadership program provides training in science and mathematics for teachers in grades K–9 using the AIMS integrated mathematics/science approach. Intensive training is provided in the physical, biological, earth science, and mathematics topics and the science process skills.

Participants receive 300 hours of instruction in a two-summer sequence. During each academic year following, the participant provides a minimum of 40 hours of instruction to teachers in the local district or region.

Upon successful completion of these requirements, trainers qualify to become members of the AIMS National Leadership Network, conduct AIMS workshops, teach AIMS in-service courses for college credit, and serve as AIMS consultants to help meet the widespread demand for such services.

The program the first summer consists of the AIMS National Leadership Institute (three weeks in July). The second summer schedule consists of the Festival of Mathematics (two weeks in late June). Write for current information.

AIMS One-Week Summer Workshops

The AIMS Education Foundation will offer 50 or more one-week AIMS Workshops nationally each year. The sites are selected from applicant educational organizations who wish to serve as the hosts. Each workshop is of five days duration and includes 30 hours of instruction, primarily hands-on, in AIMS. Most are offered in three grade level sections, generally K–1, 2–4, and 5–9. Participants receive $50+ in materials.

Host agencies agree to provide appropriate classroom space and related services at no cost to the Foundation and to cooperate in the promotion of the workshop. This is the only cost to the host agency. The AIMS Education Foundation pays all instructional costs; the housing, meals, and travel of instructors; and workshop materials and supplies. During 1990 the cost per participant is $195. Instructors are members of AIMS National Leadership Network.

Educational agencies interested in making application to host a workshop should request current information and application forms.

AIMS On-Campus Workshops

Each summer AIMS offers one-week AIMS Workshops at Fresno Pacific College in Fresno, California. The program directors of the AIMS Education Foundation and key members of the AIMS National Leadership Network serve as instructors. Two semester units of graduate credit are available.

Science Festival and Festival of Mathematics

Fresno Pacific College offers outstanding programs each summer: the Science Festival and the Festival of Mathematics. Guest faculty include some of the nation's most highly regarded mathematics and science educators. Provision is made for all grade levels from kindergarten through high school.

These two Festivals offer a unique educational experience and annually draw a total enrollment of more than 600 teachers from across the nation.

"A Day with AIMS"

"A Day with AIMS" offers an intensive one- and two-day AIMS workshops to introduce teachers to AIMS and its philosophy. Participants become familiar with the basic principles incorporated into AIMS; engage in an extensive series of hands-on AIMS investigations; and discuss classroom management and methods for integrating AIMS into the curriculum. Participants receive more than $30 worth of materials, including their choice of two AIMS publications. These workshops can be offered ***in any part of the nation*** based on a minimum enrollment of 30 participants. The cost is $70 per person.

Information Request

Please send current information on:

_____ AIMS National Leadership Program
_____ AIMS On-Campus Workshops
_____ AIMS Off-Campus Workshop Schedule
_____ Science Festival
_____ Festival of Mathematics
_____ "A Day with AIMS" Schedule
_____ "A Day with AIMS" hosting information

Name: _____

Address: _____
Street City State Zip Code

Mail to: **AIMS Education Foundation, P.O. Box 8120, Fresno, CA 93747**

Extend AIMS Lessons with Children's Literature

During summer AIMS workshops Debby Deal and Gale Kahn encouraged teachers to submit the names of favorite books that related to various AIMS activities. Below are two such lists, one for primary grades and the other for middle grades. We encourage our readers to help us expand these lists. AIMS places heavy emphasis on the integration of learning and is pleased to print the following information.

PRIMARY

Lesson Topic	Book Title	Author
Feet/Shoes	Foot Book	Dr. Seuss
	The Aminal	Bulian
	The Very Worst Monster	Hutchins
	Shoes	Winthrop
	Funny Feet	Weiss
Fruits/Vegetables/Health	The Very Hungry Caterpillar	Carle
	Gregory, The Terrible Eater	Sharmat
Seeds/Leaves	Reason for a Flower	Heiler
	Fall of Freddie Leaf	Buscaglia
	Pumpkin, Pumpkin	Titherington
Detective	Detective Whooo	Panek
Ghosts	Georgie The Ghost Book	Bright
	The Haunting of Grade 3	???
	Cranberry Halloween	Devlin
	Great Halloween Scare	???
	The Ghost Eye Tree	Martin
	Little Old Lady Who Wasn't Afraid of Anything	Williams
Rainbow	Plant a Rainbow	Ehlert
	Little Blue and Little Yellow	Lionni
Flower	Plant a Rainbow	Ehlert
	The Reason for a Flower	Heller
Start of School	The Blanket Had To Go	Evans
Fish	Fish Out of Water	???
	Yeh-Shen	Louie
Bears	Teddy Bear Picnic	Kennedy
	Corduroy	Freeman
	When a Bear Bakes a Cake	Tomkins
	Ten Bears in My Bed	Mack
	Big Bad Bruce	Peet
	Teddy on Time	Pellowski
Eggs	Are You My Mother?	Eastman
	Chickens Aren't the Only Ones	Heller
	Seven Eggs	McKenna
	What's Hatching Out of That Egg	Lauber
Snails	The Biggest House in the World	Lionni
	Snails Spell	Ryder
Dinosaurs	Weekly Reader — Dinosaur Kit 4343 Equity Dr., Columbus, OH 43228	
	Pat Perea Materials, S/S Pub. Co. 3550 Durock Rd. Shingle Springs, CA 95682 (916) 677-1545	
	Dinosaur Pop-up Book	Barlowe
	Patrick's Dinosaur	Carrick
Popcorn	The Popcorn Book	de Paola
	Popcorn	Asch
Measurement	Inch By Inch	Lionni
	How Much Is A Million?	Schwartz
Animals	Annie and Wild Animals	Brett
	The Big Snow	Hader
	Dear Zoo	Campbell
	Animal Fact/Animal Fable	Simon
	Animals Born Live and Well	Heller
Camouflage	How to Hide a Butterfly	Heller
	Where's Waldo	Handford
	The Trek	Jonas
	Animals Who Change Their Color	Almand
Pet Rock	Everybody Needs a Rock	Baylor
Jelly Beans	The Jelly Bean Contest	???
Eyes	People	Spier
	Illusions	Troll Assoc.
Art	Make a World	Emberley
Hermit Crabs	Does Anyone Know Where a Hermit Crab Goes?	???
Space/Sun	The Sun Our Nearest Star	Branley
	What Makes Day and Night	Branley
	Done in the Sun	Hillerman
Weather	Snow is Falling	Branley
	Sunshine Makes the Seasons	Branley
	Flash, Crash, Rumble and Roll	Branley
	Cloudy with a Chance of Meatballs	Barrett
Shadows	Shadow Chaser	Cosgrove
Miscellaneous	Do You Know?	Ford
	The King Who Rained	Gwynne
	The Jolly Postman	Ahlberg
Creature Features	Where the Wild Things Are	Sendak
Fun Fruits	Huge Harold	Peet
	Hubert's Hair Raising Adventure	Peet
Bubbles	Unbelievable Bubble Book	Cassidy
Apples	Ten Apples up on Top	Dr. Seuss
Observation	Anamalia	Base
	Wilfred Gordon McDonald Partridge	Fox
	Do Not Open	Turkle
Corn	Corn is Maize	Aliki
Moon	Moonbeam on a Cat's Ear	Gay
Questions	How Come?	Richards
Nature	King's Flower	Anno
Body Parts	Here Are My Hands	Martin, Jr.
Insects	Squiggly Wiggly's Surprise	Shapiro
	How Many Bugs in a Box	Carter
Senses	Series. . . Sight, Hearing, Touch, Smell, Taste	Ruis
Self Esteem	Quick as a Cricket	Wood
Birds	Owl Moon	Yolen
Numbers	Anno's Counting Book	Anno
Water Fun	King Bidgood's in the Bathtub	Wood
Magnets	Mickey's Magnets	Cranley
Serial Ordering	Where in the World is Henry?	Balian
Asking Questions	Owly	Thaler
Heat, Water	Snowy Day	Keats
Earth/Physical Science	Pecos Bill	Kellogg
Songbook	All Year Songbook	Scholastic
Plants	Seedling Child	Bornstein
Critters	Fables	Lobel
	Aster Ardvarks Alphabet Adventures	Kellogg
	Barn Dance	Martin
	Q is for Duck an Alphabet Guessing Game	Elting
	Silkworms	Johnson
	Very Hungry Caterpillar	Carle
	Predator Prey Puppets	Mah
	Beastly Neighbors	Rights
Foods	Alligator Arrived with Apples	???
	A Potluck Alphabet Feast	???
	Crescnt Dragonwagon	???
Spiders, Lettuce	Lady and the Spider	McNulty

MIDDLE GRADES

Lesson Topic	Book Title	Author
Rocks	Everybody Needs a Rock	Baylor
	Sylvester and the Magic Pebble	Steig
Measurement	How Tall Was Milton	Lowery
Insects	101 Bug Jokes	Eisenberg
General Information	What?	Reece
	Random House Book of Poetry	Prelutsky
Camouflage	How to Hide. . . Series	Heller
Seasons	Frederick	Lionni
Animals	Animals Born Alive and Well	Heller
Ecology	Introducing Ecology: Nature at Work	British Museum
Music	Peter and the Wolf	
Senses	Look Again	Hoban
Fractions	Gator Pie	Mathews
Boats	Paddle to the Sea	???
	Three Days on a River in a Red Canoe	Williams
Geology	Ming Lo Moves the Mountain	Lobel
Classification	Bruno Brontosaurus	Rubel
Weather	Cloud Book	de Paola
Bears	Baby Bears	National Geographic
	Happy Birthday Moon!	Asch
	Corduroy	Freeman
	Who Wants an Old Teddy Bear?	Hofmann
	Teddy Roosevelt and his Teddy	???
Popcorn	The Popcorn Book	de Paola
Numbers	How Much Is a Million?	Schwartz
Multiplication	Bunches & Bunches of Bunnies	Mathews
Language	The Jolly Postman	Ahlberg
Money	Alexander Who Used to be Rich Last Sunday	Viorst
Mirrors	The Mirrorstone	Palin
	If You Give a Mouse a Cookie	Numeroff

Mathematics: A Way of Thinking
Center for Innovation in Education
19225 Vinegar Lane
Saratoga, CA 95070

Family Math
Univ. of California, Berkeley
Lawrence Hall of Science
Berkeley, CA 94720

Materials List

CONSUMABLE ITEMS

- ____ popsicle sticks
- ____ thread
- ____ transparent tape
- ____ ziploc type bags
- ____ water
- ____ paper cups
- ____ heavy string
- ____ food coloring (red, blue, yellow)
- ____ large chart paper
- ____ glue
- ____ construction paper
- ____ large sheet of paper to make megaphone
- ____ balloon
- ____ magazine pictures
- ____ stickers (happy face)
- ____ cellophane
- ____ paper towels
- ____ ice cubes
- ____ items to help keep ice cubes—paper towels, cloth, foam rubber, plastic wrap, foil, etc.
- ____ paper plates
- ____ black paint
- ____ candle wax
- ____ liquid soap such as Sunlight and Dawn

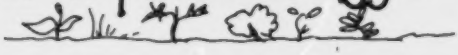
NON-CONSUMABLE ITEMS

- ____ wooden rulers
- ____ tuning fork
- ____ ping pong ball
- ____ rubber bands
- ____ pencil
- ____ clear glass pan
- ____ overhead projector
- ____ cork
- ____ Slinky (plastic works well)
- ____ wind up clock (or music box)
- ____ metal can
- ____ paper bag
- ____ glass jar
- ____ shoebox with newspaper
- ____ paper clips
- ____ glass bottles
- ____ plastic eggs
- ____ egg box
- ____ items for eggs—marshmallows, rice, beans, cotton, dice, paper clips, key, marbles, pennies, toothpicks, macaroni, thread
- ____ noisemakers—pencils, bell, seeds in cup
- ____ small mirrors
- ____ crayons
- ____ hand lens
- ____ teddy bear counter
- ____ flashlight
- ____ items to test for light—glass jar or window pane, white paper, piece of plastic (transparency film), cardboard, aluminum foil, waxed paper, tissue paper, glass of water, mirror
- ____ plastic cup
- ____ prism
- ____ leaf
- ____ penny
- ____ bowls
- ____ thermometers
- ____ scissors
- ____ styrofoam cups
- ____ large jar or small aquarium
- ____ small bottle or baby food jar
- ____ metal rod (metal knitting needle, metal clothes hanger, etc.)
- ____ thumbtacks
- ____ metal spoon
- ____ plastic spoon
- ____ wooden spoon or stick
- ____ frozen juice can (or any small metal can)
- ____ flat plate
- ____ large plastic bowl
- ____ materials for instruments (see Instrument Ideas page)

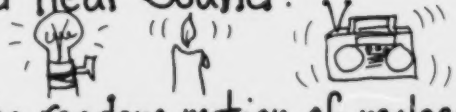
What is Energy?

Energy is very hard to define. It is not matter, does not have mass, nor can you hold it in your hand. It takes energy to move a car, boil a pot of water, light a classroom, or even play at recess. Energy appears in many forms-heat, light, sound, nuclear, and geothermal. Though each form is very different, they are all the same in the fact that one form of energy can change into another.

Most of the energy used on earth comes from the sun. The sunlight hits the earth, is absorbed, and changed to heat energy that in turn warms the air. Sunlight is combined with carbon dioxide in green plants. Human and animal life depend on these stored sugars in plants to provide energy to operate their bodies and muscles.



Energy can be explored in various ways—through light, heat, sound, and in conversions from one to another. We can see light, feel heat, and hear sound.



Heat energy is the random motion of molecules. Molecules in matter are always in motion, but the hotter something is, the faster the molecules move. Temperature is a measure of that motion.

Sound waves carry energy in a regular back and forth motion of molecules (vibrations). All sounds can be traced back to a vibration of something.

Energy is carried in light waves. Most objects do not emit their own light but reflect light from other sources. Our primary source of light is the sun.

The total amount of energy does not change. Energy can be changed from one form to another but it can never be created or destroyed. This is known as the law of conservation of energy.

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Sound Energy

Sound is all around us. Wind moving through trees, cars going down the street, friends laughing, music playing, and countless other sounds surround us. Hearing never stops, not even when we sleep.

All sounds we hear have one thing in common. Sound is produced by objects vibrating back and forth which make sound waves. These vibrations are transmitted to anything the vibrating object touches, including air. The waves go out in every direction so that if you could see them, they would look like concentric rounded shapes spreading out from the source, like ripples that spread out when a pebble is dropped in a pond. The plucking of the strings of a guitar causes it to vibrate. The movement of the strings pushes against the adjacent air molecules in a back and forth manner. The disturbed air molecules in turn push against neighboring molecules, disturbing them and so forth. The molecules do not move very far but the energy travels away from the strings at the speed of sound.

Sound travels through solids, liquids, and gases at different speeds. It travels about 330 meters (1,129 feet) per second through air, 1500 meters (4,794 ft) per second through water, and 4,500 meters (12,620 feet) per second through wood. The only thing that sound cannot travel through is an absolute vacuum.

The sense of hearing involves the ear, ear drum, auditory nerve, and the brain. The outer ear picks up sound waves and transfers vibrations through the ear canal to the eardrum where is passes to three tiny bones that stimulate nerve cells. The auditory nerve carries the electrical impulses to the brain where it is interpreted as sound.

Sounds can be high or low. The difference in the highness or lowness of sound is called pitch. Pitch depends on the speed of vibration of the sound source. If an object vibrates very fast, the ear will receive many vibrations per second and the brain will interpret it as a high pitch. The faster the vibration, the higher the pitch. Humans can hear vibrations between 20 and 20,000 cycles per second. Sounds of higher frequency can be heard by animals such as dogs, bats, and dolphins.

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Sound is Vibration

I. Topic Area
Physical Science—Sound—Vibrations

II. Introductory Statement
The students will learn that vibrating objects produce sounds and cause vibrations in whatever they touch.

III. Math Skills
Comparing
Problem Solving

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing conclusions
Interpreting data

IV. Materials
Wooden rulers
Tuning forks
Popsicle sticks
Ping pong ball
Thread and tape
Rubber band
Pencil

V. Key Question
How is sound made?

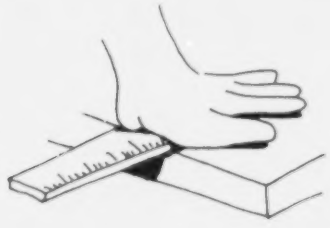
VI. Instructional Information
Energy must be used to produce sound. Whether it is the plucking of the strings of a guitar, the striking of a drum, or the blowing of a trumpet, energy is involved. The energy causes the object to vibrate, producing sound.

Whenever a sound is produced something is quivering, throbbing, vibrating. Such movements are the basis of the sound we hear. It can be something we see, like a violin string vibrating or it can feel like the vibration of a person's vocal cords or it can be a ticking clock. All sounds can be traced to a vibration of some material.

In order to hear sounds, the vibrating material must move back and forth at least 16 times per second. The vibrating material may be a solid, liquid or gas.

VII. Management Suggestions
1. Attach a 12" piece of thread to the ping pong ball.
2. Wrap the rubber band around the ruler lengthwise and push a pencil underneath the rubber band.
3. Have a large chart or butcher paper to record the students' observations.

VIII. Procedure
1. Begin by asking the students to close their eyes. Have them listen for all the sounds they can hear. Encourage the students to describe the sounds they hear and judge whether the sound is high or low, etc. Record on a large chart the students' observations.
2. Do worksheet "Listen to Sounds".
3. Discuss that all sound is produced through vibrations that make sound waves.



4. Use a ruler to produce a vibration. Place the ruler on a desk so one end sticks out over the edge. Pluck the ruler with a finger as you hold the other end tightly against the desk.
5. Shorten the amount of ruler sticking out and pluck the ruler again. Ask the students if there is a difference in sound. When you make the ruler shorter is there a change in sound? (Yes, the pitch is higher)
6. Tell the students to clench a popsicle stick between their teeth. Have them pluck the end sticking out and listen to the vibrations. Can they also feel the vibrations?
7. Vibrations can also be demonstrated by striking a tuning fork and touching a ping pong ball that is hanging by a thread. (The vibration from the tuning fork will violently kick the ping pong ball away.)

8. Demonstrate that vibrations can not only be seen, but can be felt. Have the students place their hands flat on their desks; move around the room with a vibrating tuning fork and touch the handle to the desk of each child. Ask the students what they feel.
9. Make a one-string ukulele by wrapping a rubber band around a ruler lengthwise. Push a pencil underneath the rubber band. Pluck the rubber band. Move the pencil and pluck again. Listen to the change in sound and watch how the rubber band vibrates.
10. Do worksheet "Sound is Vibration".

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X. Discussion Questions

1. What do all sounds have in common? (vibrations, movement energy)
2. What do vibrations look like? (objects moving back and forth rapidly)
3. What do vibrations feel like? (tingly, wiggly, etc.)
4. Describe the change in the sound when you move the pencil and change the length of the rubber band. (the sound becomes higher or lower. The rubber band vibrations are different.)
5. What caused the ping pong ball to bounce away from the tuning fork? (vibrations)

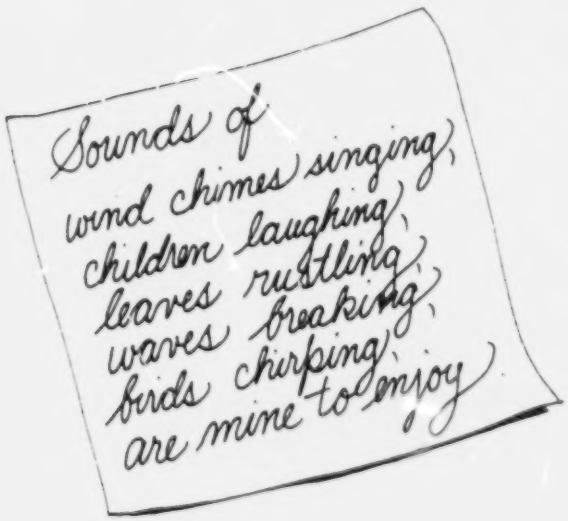
XI. Extensions

1. Have the students use the lists of sounds they made to create a poem. For example, the form of the poem could be

SOUNDS

I hear girls giggling,
cars honking,
leaves rustling,
people singing,
special sounds,
with my ears.

2. Have the students remember sounds that they enjoy hearing. List their responses on a chart labeled "I Like to Hear....", then have them remember sounds that they do not like to hear and add those to the list under "I Do Not Like to Hear...." Later recategorize the list into high, low, loud, and soft sounds.
3. Brainstorm some important sounds and how people should react to them. (fire alarm, fire engine and ambulance siren, school bell, smoke detector alarm, teacher's or policeman's whistle)



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Name _____

Listen to Sounds

1. Close your eyes and get very quiet. Listen to all the sounds you can hear in one minute.

2. Open your eyes. Make a list of the sounds you heard.

3. Go outside and sit quietly.
   - Shut your eyes and listen for at least 1 minute.
   - Open your eyes and make a list of the sounds you heard.

Indoor Sounds

1. _____	7. _____
2. _____	8. _____
3. _____	9. _____
4. _____	10. _____
5. _____	11. _____
6. _____	12. _____

Outdoor Sounds

1. _____	7. _____
2. _____	8. _____
3. _____	9. _____
4. _____	10. _____
5. _____	11. _____
6. _____	12. _____

How were the sounds alike? _____

How were the sounds different? _____

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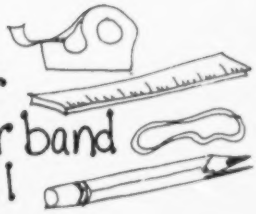
Name _____

Sound is Vibration

You will Need: Tuning fork, water, ping pong ball, thread, tape, ruler, rubber band, pencil

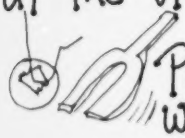


Do This:

1. Hold one edge of a ruler tightly on your desk. Pluck the other end of the ruler lightly. Listen
   Make the ruler shorter. Make the ruler longer.

2. Clench a craft stick with your teeth. Pluck the end of the stick and listen. Change the length and try again.

3. Strike a tuning fork and observe. (Watch and listen.) Put the vibrating tuning fork in water. Watch.



   Put a ping pong ball on a thread. Touch the ball with a vibrating tuning fork. Watch.

   Touch your desk with a vibrating tuning fork. Feel.

4. Make a mini-ukulele. Wrap a rubber band around a ruler. Push a pencil under the rubber band. Pluck the rubber band. Move the pencil and try again.

5. How are all these activities alike? _____

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Traveling Sounds

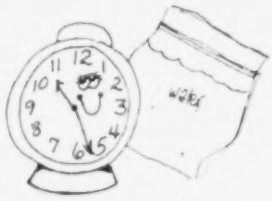
I. Topic Area
Physical Science—Sounds

II. Introductory Statement
The students will be able to explain that sounds travel through air, water, and wood.

III. Math Skills
Comparing
Estimating

Science Processes
Observing
Communicating
Predicting
Drawing conclusions

IV. Materials
Wind up clock (music box, two metal spoons)
Large ziploc type bag
Water
Table top
Metal can
Paper bag
Glass jar
Shoe box with newspaper



V. Key Question
Can sounds travel through solids, liquids and gas?

VI. Instructional Information
Sound waves travel through every kind of material; the only place sound cannot travel is through a vacuum because there is nothing to vibrate.

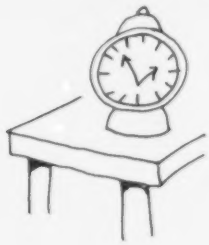
Solids, liquids, and gases are all conductors of sound, but the speed of sound is different for each type of material. Most sounds that we hear are transmitted through air. Sound waves travel much faster through solids and liquids than through gases because the molecules are closer together.

Sample speeds:

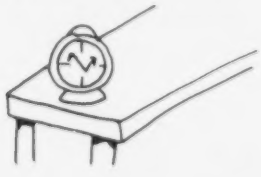
Air	330 meters/sec.	1129 ft./sec.
Water	1500 meters/sec.	4794 ft./sec.
Wood	4500 meters/sec.	14850 ft./sec.
Metal	5000 meters/sec.	16500 ft./sec.

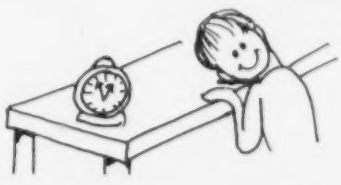
VII. Management Suggestions
1. Fill the ziploc type bag with water and seal tightly.
2. Collect a coffee can, paper bag, glass jar and shoe box with newspaper. They must be large enough to put the clock inside.

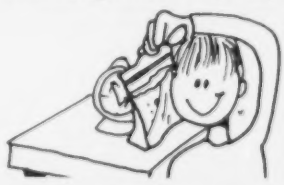
VIII. Procedure
1. Wind up a clock. Have the students close their eyes and listen to the clock ticking. (If you do not have a wind-up clock, use a music box or hit two spoons together.) See worksheet "Traveling Sounds".



2. Have the students raise their hands if they can hear the ticking. Ask, "What is the sound traveling through?"
3. Explain that the air is a gas. Sound is the movement of molecules of the air.
4. Have the students press their ear against a wood surface (table top, desk, wooden floor) and place the clock on the table top some distance from the children's ear. Ask, "Can you hear the sound?" "Is the sound louder or softer than when you hear it through air?" (louder)
5. Fill a ziploc type bag with water. Have a child hold it to his/her ear. Put the clock on the other side of the bag. Ask the child, "Can you hear the clock ticking?"
6. Ask, "Does sound travel better through air, wood, or water?" (wood—a solid substance)
7. Put the clock inside each of the following: a metal can, paper bag, glass jar, and a shoe box with newspaper. Have the students tell when the sound was the loudest and when it was the softest.
8. Try having the students press their ear against a metal surface (metal cabinet, metal door, or metal ruler) and put the clock on the metal surface. "Does sound travel through metal?" (Yes!)







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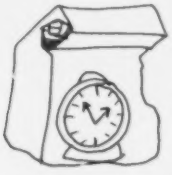
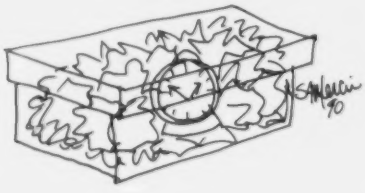
IX. Discussion

1. Sound was the loudest when it traveled through what material? (wood and metal)
2. Sound was the softest when it traveled through what material? (shoe box and newspaper)
3. What does sound travel through? (water, air, plastic, wood, paper, glass, metal—everything)
4. Why do you think the sound is louder when you hear it through metal and wood than through air? (the molecules of metal and wood are closer together)

X. Extensions

1. Take the students outside and have them press one of their ears to the earth. Bounce a ball or stomp your feet at least 10 feet away. Ask the children if they heard you. Explain that the Indians used this method to hear approaching people. They could feel the vibrations through the earth before they could hear them through the air.
2. Have the students think of some different articles that sound can travel through and test each one. Do the activity page *What Can Sound Travel Through?* as a homework assignment.





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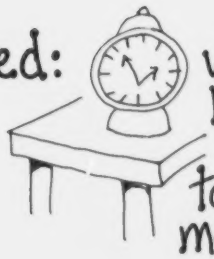
Name _____

Traveling Sounds

You Will Need:



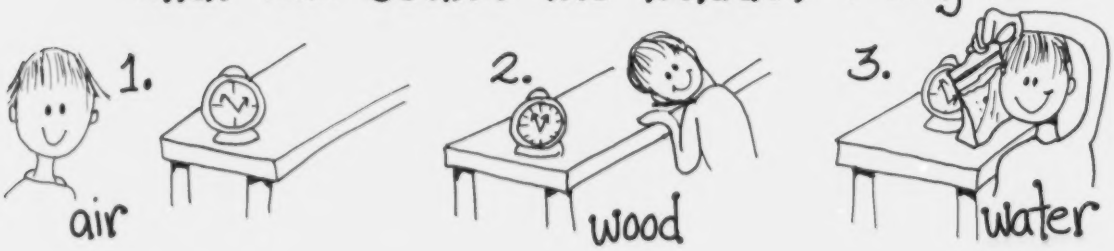
wind up clock
large plastic bag of water
table
metal can

paper bag
glass jar
shoe box
newspaper

Do This:

1. Listen to the clock. The sound is traveling through air.
2. Put the clock on a table. Press your ear to the table. The sound is traveling through wood.
3. Fill a plastic bag with water. Listen to the clock through it. The sound is traveling through water and plastic.

When was sound the loudest? Why?



4. Put the clock inside a metal can, paper bag, glass jar, and a shoebox with newspaper.

When was the sound softest? Why?

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Name _____

What Can Sound Travel Through?

Make a list of your predictions. Test each one. Then make a new list of things you found that sound could travel through.

I think that sound can travel through these things.

I plan to test my predictions by _____

_____

_____

I found out that sound travels through these things.

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Paper Cup Telephone

I. Topic Area
Physical Science—Sound

II. Introductory Statement
The students will be able to demonstrate how sound travels through solids.

III. Math Skills
Measuring
Comparing
Basic Computation

Science Processes
Observing
Communicating

IV. Materials
Paper cups
6 meters heavy string
Sharp pencil
Paper clips

V. Key Question
Can sound travel along a string?

VI. Instructional Information
This experiment is an effective way to show that sound waves travel through solids better than through air. The vibrating string can carry sound and, when the vibration is stopped, the sound is stopped.

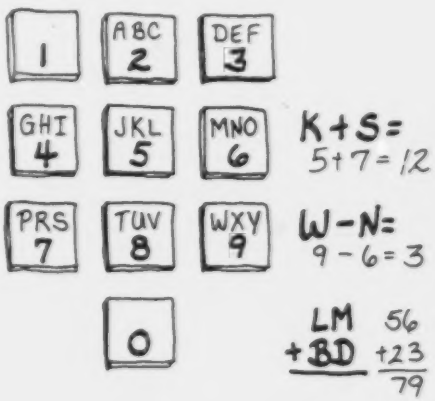
If we hear someone talking in the next room when all the doors are closed, we are hearing sound that has traveled through air and then through the wall and then through the air of the room we are in.

VII. Management Suggestions
1. In introducing this experiment, ask the students if they think string will conduct sound.
2. Pass out the string and have the students stretch it out and pluck the string. Ask the students if they hear anything.

VIII. Procedure
1. Make a small hole in the center of the bottom of each cup with a pencil.
2. Pull each end of the string through the holes in the cups.
3. Tie a knot in the end of the string or tie the string to a small paper clip.
4. Do the same thing to the other paper cup.
5. Pull the string tight.
6. Have one student talk into one cup while another student holds the other cup over his/her ear.
7. Ask the students, "How did your voice reach the other person's ear?" (through the vibrations of the string)
8. Explain that when one person speaks into the cup, the sound travels in waves along the string and makes the other cup vibrate, too. This is how sound travels between the cups.
9. Try "Slinky Sound" on the following page. Does it sound different from the paper cup phone?

IX. Discussion Questions
1. What is transmitting the sound? (the string)
2. Could you see the string vibrate? (no)
3. Could the voices be heard if the cups were not fastened to each end of the string? (probably not)
4. What did you have to do in order to hear your partner's voice? (stretch the string tight and speak into the cup)
5. How is the styro-phone like a real telephone? Like a radio with head phones? (the sound vibrations travel through wires from place to place like the string of the cup telephone)

XI. Extensions
1. Make a phone tap by crossing one set of phone lines over another. (The string must be looped over the string it crosses.)
2. Have the students find out how long the string can be and still be able to hear someone talking.
3. Try using some other material such as wire, heavier rope, yarn, roving, etc., to see which one conducts the vibrations the best.
4. Make the lion on a following page and see if the children can make the lion roar by moving their fingers along the string. Can you think of any other animal sound you can make?
5. Lead the class in a discussion about how their lives would be different if we had no telephone for communication.
6. Use the drawing of the telephone dial as a code page math.



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Name _____

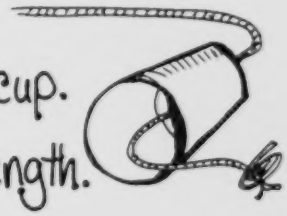
Slinky Sound

You Will Need:

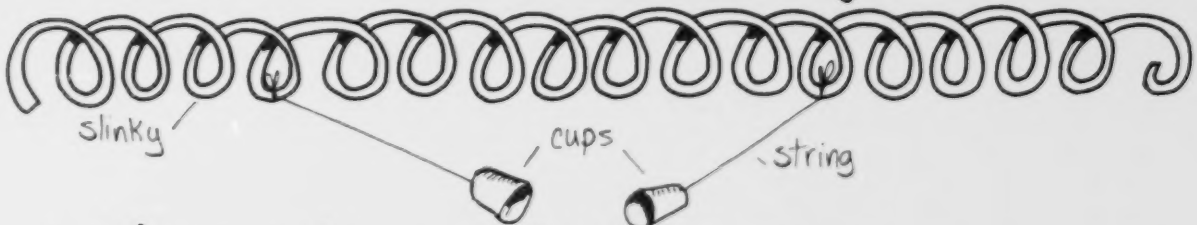
2 paper cups
1 meter of string
2 paper clips
1 toy metal slinky

Do This:

1. Make a hole in the bottom of each cup.
2. Cut the string in half. Insert one end of each string into each of the cups.
3. Tie each string to a paper clip inside each cup.
4. Stretch the slinky to about 2 meters in length.



5. Tie the end of one of the strings to the slinky. Tie the other string near the first one.
6. Put both cups to your ears. Have a partner pluck one end of the slinky.
7. Listen! What does it sound like to you?



8. Try a coat hanger, fork, or spoon.

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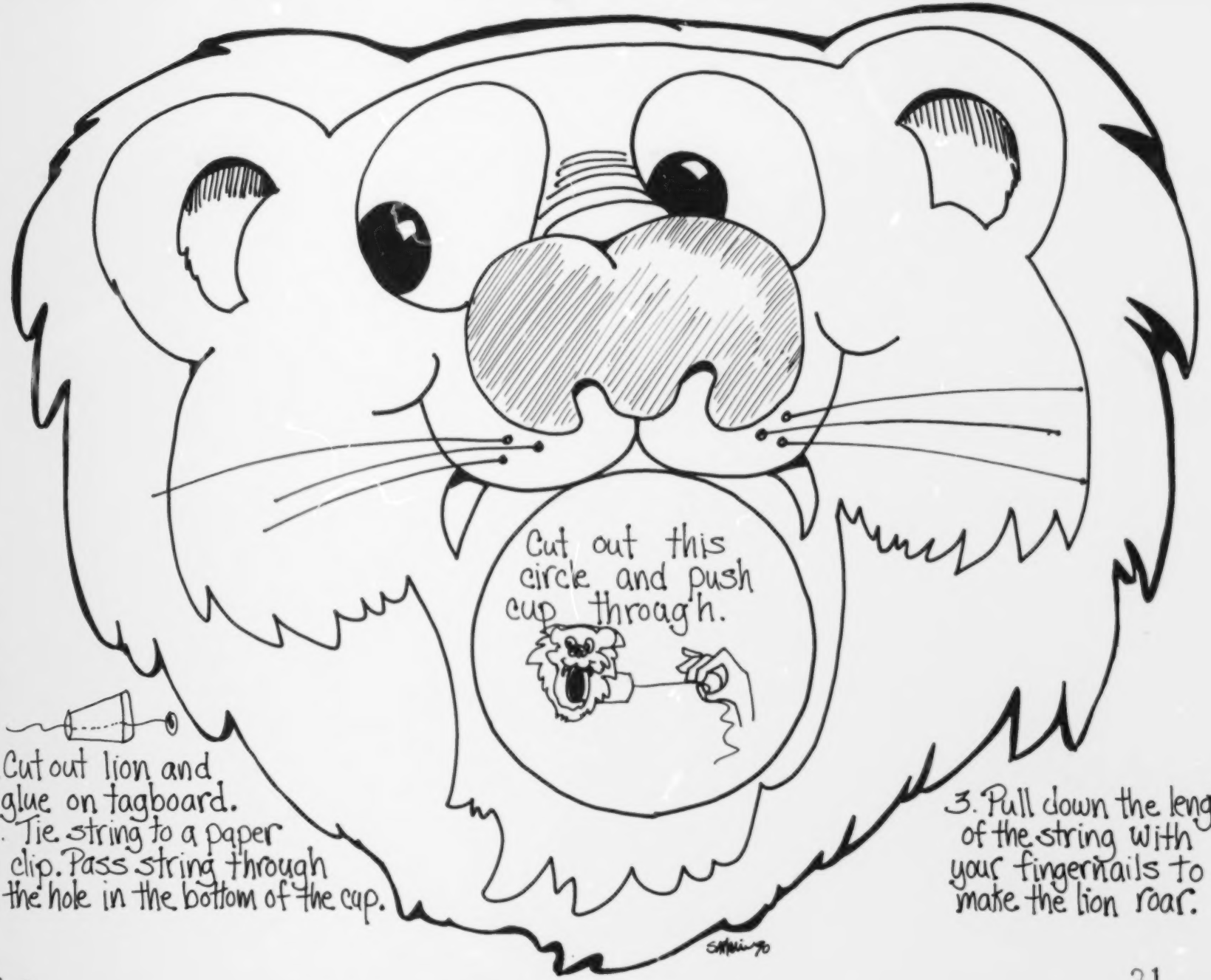

1. Cut out lion and glue on tagboard.
2. Tie string to a paper clip. Pass string through the hole in the bottom of the cup.

3. Pull down the length of the string with your fingernails to make the lion roar.

MY STYRO-PHONE

My Styro-phone is a wondrous thing
I can talk to my friend at the end of my string
Just by whispering a word in my cup.
I can hear every word without turning it up!

by Karen Adler

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Musical Bottles

I. Topic Area
Physical Science—Sound

II. Introductory Statement
When glass bottles filled with different levels of water are tapped, students will be able to hear a difference in sound.

III. Math Skills
Measuring
Comparing
Graphing
Estimating

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing conclusions

IV. Materials
5 glass bottles—filled to different heights with water
Food coloring—red, blue, yellow, green, orange
Wall chart
Glue
6" x 18" construction paper strips
Student page

V. Key Question
Does the sound change when the level of water in the bottles changes?

VI. Instructional Information
Vibrating objects produce sound by causing vibration in whatever they touch. All sounds are made by things vibrating. Some things vibrate fast and make a high sound. The slower something vibrates, the lower the sound it makes. Pitch is the highness or lowness of sound. When a bottle is tapped, the glass vibrates and makes sound. By adding different levels of water, the pitch of the sound can be changed. The bottle with the least amount of water will vibrate the fastest and have the highest pitch. The one with the most water will vibrate the slowest and have the lowest pitch.

VII. Management Suggestions
1. Get 5 glass bottles that are identical.
2. Prepare the 5 bottles of water, each with a different level of water.
3. Use only the three colors of food coloring—red, blue, and yellow—and let the students mix the colors to get orange and green.
4. Prepare the graph and markers for the students' predictions.

VIII. Procedure
1. Show the students a toy xylophone and ask them to describe it. They will notice the colors, but keep trying until someone observes the size difference in the metal plates. Play the xylophone to demonstrate high and low pitch. Tell them that small objects vibrate fast and large objects vibrate slowly.
2. Place the 5 bottles, each with a different level of water, on the table and ask the students if the bottles will make a sound if they are hit with a pencil. The students should say "yes!"
3. Put different food coloring in each bottle.
4. Show the graph and ask the students to predict which bottle will make the highest sound or pitch. Have the students record their prediction. Use markers or self-sticking dots on graph—one color for boys, one color for girls.
5. Have several students come up to test the bottles using a pencil to cause the vibration. Help them hear that the bottle with the most water has the highest pitch.
6. Try blowing into the bottles to produce sound. The results will be the opposite of when the bottles were struck. It is the air in the bottles vibrating this time, so that the bottle with the least air (most water) will have the highest pitch and the one with the most air (least water) will have the lowest pitch.
7. Have the children try to tap out a song on the bottles. The teacher should do it first. Try "Twinkle, Twinkle, Little Star" or "Row, Row, Row Your Boat."
8. Pass out the worksheets and have the children color the water in the bottles to match the colors of the real bottles.
9. Cut out pattern strips (6" x 18" construction paper).
10. Tell the children to cut out the bottles and glue them to a pattern strip to make their own songs.
11. Have the students play their songs for the class.

IX. Discussion Questions
1. Which bottle had the highest sound when it was struck? Blown into?
2. Which bottle had the lowest sound when it was struck? Blown into?
3. Why did the bottle with the least water have the highest pitch when struck and the lowest pitch when blown into? (the glass was vibrating when the bottle was struck and the air was vibrating when the bottle was blown into)
4. Could you make up a song to play on the bottles?

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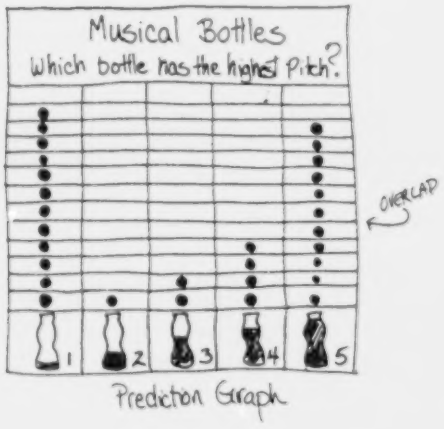
X. Extension

1. Estimate the number of spoonfuls of water in the fullest bottle.
2. Put some other material in the bottles (sand, jello, beans). Does it sound the same?
3. Draw pictures to music. Listen to music with your eyes closed, then draw what you see.
4. Use the graph for math drills. Ask questions like:
   —How many girls voted for blue?
   —How many boys voted for red?
   —How many more boys voted for red than girls?
   —If I add blue, red, and green votes, how many do I have in all?
   —How many more people voted for red than green?
5. The concept of pitch can be further developed by using the stories *Goldilocks and the Three Bears, Little Red Ridinghood,* and *The Three Billy Goats Gruff.* The children can act out the pitch changes for the main characters.



Prediction Graph

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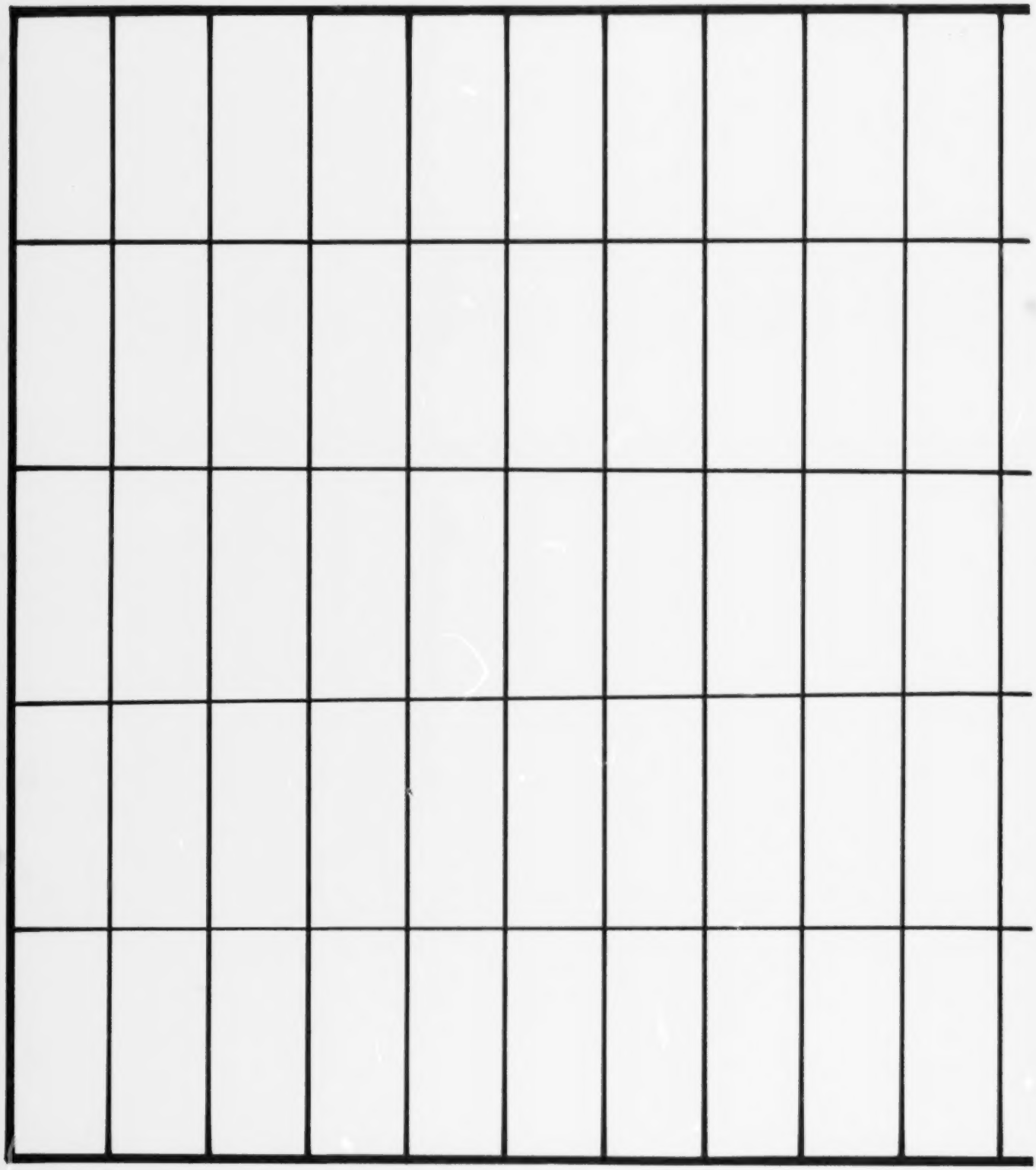

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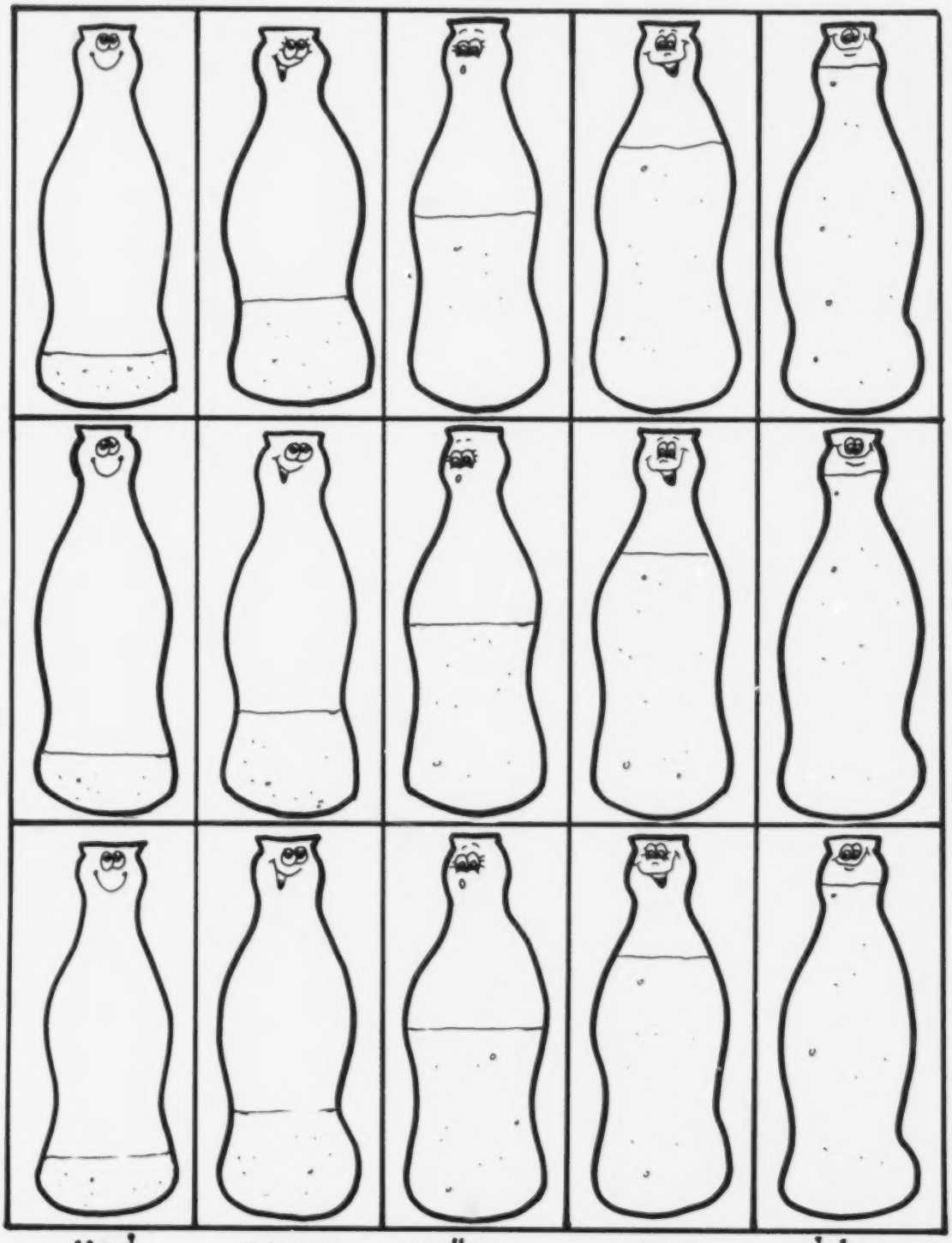
Musical Bottles

Color, cut out, and glue on pattern strips to make songs. Play your music for an audience.



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Sound of Voices

I. Topic Area
Physical Science—Sound—Larynx

II. Introductory Statement
The students will be able to explain that sound is produced by the vocal cords of the body.

III. Math Skills
Comparing

Science Processes
Observing
Communicating
Predicting

IV. Materials
Balloon

V. Key Question
How is the sound of the human voice made?

VI. Instructional Information
The human voice is produced in the larynx. The vocal cords, two small folds of tissue, stretch across the larynx. As air from the lungs rushes past the vocal cords, they vibrate, producing the sound of the voice.

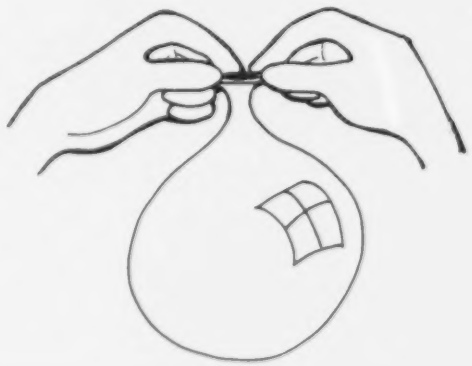
This experiment will give the students an idea of how their vocal cords work. The air in the balloon represents the air that you use to talk. The mouth of the balloon is your vocal cords which vibrate as the air passes, and you make sounds.

VII. Management Suggestions
1. Get a large balloon if you can; it holds more air.
2. The teacher could read some or all of the page "Throat Strings" to the students.

VIII. Procedure
1. Have the class put their hands on their throat and hum. What do they feel?
2. Where are the vibrations coming from? (your vocal cords)
3. How do your vocal cords make sounds? (your vocal cords vibrate to make voice sounds)
4. Blow up the balloon.
5. Grasp each side of the balloon with the thumb and forefinger of each hand just below the balloon's opening.
6. As the air escapes from the balloon, pull on each side of the balloon. What happens as the rubber vibrates? (it lets out a sound)
7. Stretch the mouth of the balloon even more and let some of the air out of it. As the rubber is pulled tighter, what happens? (the sound gets higher)

X. Discussion Questions
1. You make voice sounds when you breathe out. Can you make the same sound breathing in? Try it.
2. Can you whistle while breathing in? Try it; is it easy?
3. What part of the human throat does the mouth of the balloon represent? (vocal cords)
4. What does the air in the balloon represent? (the lungs)

XI. Extension
1. Have the students make a list of words to describe sounds people make. Examples are talking, speaking, yelling, coughing, singing, crying, laughing, giggling, whispering.
2. Perform the "Voice Box Reader's Theater." Individuals or small groups say the first nine lines, then the whole group joins in on the final two lines.



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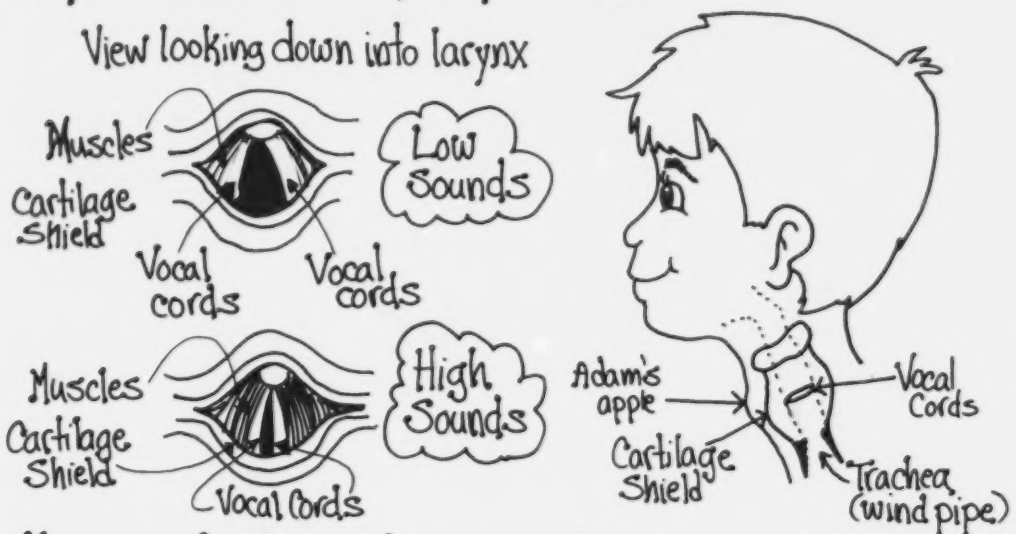
Voice Box

When you breathe, the air goes through your nose into your windpipe. The windpipe is a hollow tube leading from the back of your throat towards the lungs. At the top of the windpipe is a hollow organ called the voice box or larynx. It is made of bone and cartilage held together by ligaments and muscles.

The vocal cords in your voice box are two, straight, elastic-like strings. When you are not speaking or singing, these cords are relaxed against the sides of your voice box. When you start to talk or sing, tiny muscles bring the vocal cords closer together. Air coming up from the lungs makes the vocal cords move back and forth very fast (vibrate). When vocal cords vibrate, sounds are produced. Stretching the vocal cords tight and thin makes your voice high and squeaky. Relaxing them to a loose and wide shape makes low, deep sounds.



You can find your larynx just behind the bump in your throat called the Adam's apple. Feel around for the cartilage shield. The larynx is right behind it. Put your hand on your larynx and hum or talk. Feel the vibrations. Make the lowest sound that you can. Now make the highest sound. Feel the muscles move.

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Voice Box

Readers' Theater

I can whisper. (Can you hear me?)
I can shout. (Hey! Throw me the ball!)
I can hum when I'm about. (hmmmmm)
I can laugh. (ha, ha, hee, hee, ho, ho)
I can sing. (la, la, la, la, la, la, la)
I can sob when I'm crying. (boo hoo)
I can yodel. (yo de le hee hooo)
I can talk. (Could I have another cookie please?)
I can giggle when I walk. (tee, hee.)
All these sounds my voicebox makes.
(point to larynx)
I use them all to communicate.
(all turn to each other and begin talking)

by
Chris & Sheryl
Mercier

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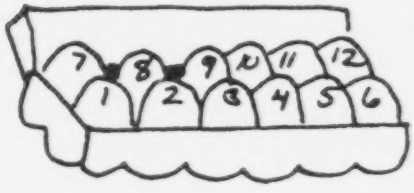
Eggs-Full of SOUND

I. Topic Area
Physical Science—Sounds

II. Introductory Statement
The students will be able to identify objects by the sounds they make.

III. Math Skills
Comparing
Estimating
Problem solving
Basic computation

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing Conclusions



IV. Materials
Plastic eggs
Egg box
Items for eggs: marshmallows, rice, beans, pins, cotton, dice, paper clips, key, marbles, bottle cap, pennies, toothpicks, macaroni, spool of thread

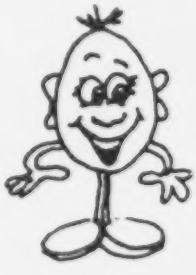
V. Key Question
Can you identify objects by the various sounds they make?

VI. Instructional Information
We have all learned to identify different things by the sounds they make even if we do not see them, i.e., a motorcycle, a door closing, money jingling, water running.

This activity will give the students a chance to identify some very common items by the sounds they make.

VII. Management Suggestions
1. Get a dozen plastic eggs, usually available in a toy store. If eggs are not available, substitute with film canisters or margarine tubs.
2. Number each egg.
3. Place the items in the plastic eggs.
4. Put the eggs in the egg box in any order.

VIII. Procedure
1. Discuss with the students various sounds that they recognize without seeing what is dropped, such as dropping a pencil, rattling some keys, closing a book.
2. Have them close their eyes and drop some familiar item or rattle some keys or ring a bell and have the students identify the sounds.
3. Tell the students that they are to identify the objects in the eggs by shaking the egg and listening to the sounds.
4. Then shake each egg and have the students listen. The students should predict what is hidden in each egg.
5. Pass out the worksheet. Have the students again shake the eggs and record their guesses by cutting out the pictures and laying them on the pictures of the numbered eggs.
6. Open the eggs and show what was actually inside each one. Students may move their guesses and glue or draw the objects on each numbered egg.



IX. Discussion Questions
1. Which objects make a loud sound? (the hard ones)
2. Which objects made a soft sound? (the soft ones)
3. Which egg sounded empty?
4. Which objects were the easiest to identify? (marbles or the key) Why?
5. Were there any other objects you could identify easily?
6. Why is it important to recognize and understand sounds? (for our safety, to understand language, to recognize friends, etc.

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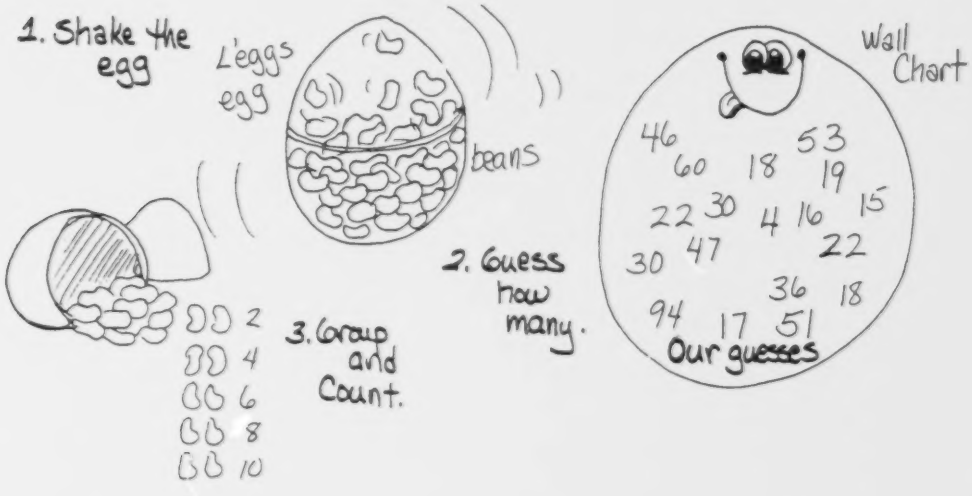
X. Extensions

1. Fill pairs of eggs with the same objects. Have the students match the pairs of eggs by their sounds.
2. Send an egg home, have parents fill the egg with mystery objects and return to school. Allow the class to guess the objects by the sounds they make.
3. Use a L'eggs egg. Hide beans inside. Shake the egg. Have the students guess the number of beans hidden inside by the sound they make. Record their guesses on an egg shaped wall chart. Ask questions like: Which guess is closest to 100...50...25? What is the highest guess? What is the lowest? Open the egg and count the objects. Repeat with a different number of beans or different objects.
4. Discuss sounds that warn us of danger, such as car horns, bells, sirens or police cars, fire engines, ambulances, bells at train crossings and so on.



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Eggs-Full of Sound

Name _____

1 2 3 4 5 6 7 8 9 10 11 12

1. Cut out the pictures.
2. Shake each mystery egg and listen.
3. Guess what is inside and put its picture on the numbered egg.
4. Open the eggs and glue the pictures to show each sound.

1 2 3 4 5 6 7 8 9 10 11 12

marshmallows | rice

beans | toothpicks

thread | cotton

dice | paper clips

Key | marbles

pennies | macaroni

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BIG EARS

I. Topic Area
Physical Science—Sound

II. Introductory Statement
The children will be able to explain that the ear is the organ of the body that receives sound.

III. Math Skills
Comparing

Science Processes
Observing
Communicating
Predicting
Drawing conclusions

IV. Materials
Paper to make a megaphone

V. Key Question
How do our ears allow us to hear sounds?

VI. Instructional Information
We hear because our ears respond to vibrations in the air. The important parts involved in hearing are protected inside the skull. The outer "ear" that we see plays only a small part in hearing. Its shape helps direct air vibrations into the ear canal. The air vibrations hit the eardrum—a tight, flexible membrane inside the ear canal—and cause it to vibrate. The vibrating causes movement in three tiny bones—the hammer, anvil and stirrup—and the vibration is sent into the inner ear. The inner ear is composed of the cochlea and the semicircular canals. The sound waves exert pressure on fluid in the cochlea where the fluid's movement is detected by the auditory nerve endings. Electrical impulses are set up in the auditory nerve and sent to the brain where they are identified as sounds.

Behind the eardrum is a tube, the Eustachian Tube which connects the middle ear to the throat. Its purpose is to equalize the air pressure on both sides of the ear drum. The semicircular canal in the inner ear is the sense organ for balance.

VII. Management Suggestion
CAUTION the students that loud sounds and sharp objects can damage the ear.

VIII. Procedure
1. Discuss why ears are important. (They allow us to hear and communicate. The ear is sensitive to a wide range of sounds—high, low, loud, and soft.)
2. Discuss with the students the different parts of the ear. (See Instructional Information) The outer ear (the part we see) and the ear drum, the middle ear with the chain of three bones, and the inner ear with the cochlea.
3. Do the worksheet "My Ear" with the students filling in blanks with the names for the parts of the ear.
4. Play a tape or record player, have the students listen to the sound. Begin with the volume off, slowly turn the volume higher and have the students raise their hands when they are able to hear the music. When all hands are raised, slowly turn the volume down until only a few hands are still up.
5. Tell the class that there is another way to "turn the volume up". Show them how to make "big ears" by putting their hands behind their ears with their palms facing outward. Have them make big ears and compare the number of students who can hear the music.
6. Set the volume of the tape player so that all students can hear. Have them listen, alternately with their "big ears" off and on. Ask them to describe the difference in the sound. They should notice that by making their outer ear "larger", they are able to "catch" more sound.
7. Explain that the ear can pick up very soft sounds and is very sensitive. Loud sounds with much energy can cause pain and damage to the ear.

IX. Discussion Questions
1. What do your hands catch when you make "Big Ears"? (sound vibrations)
2. Why do some animals (rabbits and elephants) need to have big ears? (their eyesight is poor so they rely on their keen hearing)

XI. Extensions
1. Make two megaphones. Have the students go out on the baseball diamond with one standing on home plate and the other standing on the pitcher's mound. Ask them to talk to each other (without yelling) with the megaphones. Does the sound carry? Megaphones permit sound to go out only in one direction. Thus energy is concentrated rather than being dissipated over a wide space.
2. Discuss noise pollution. Ask the class how loud noises make them feel. For example, can they work well when the class is noisy? Does a loud motorcycle sound bother them?
3. Take a listening walk. The children can apply the "big ears" technique to help them hear. Prepare the children to listen to sounds during their walk. Back in the classroom, discuss what they heard and what made those sounds. Categorize the sounds into loud, soft, high, low, near, far, people, animals, weather, if they liked or disliked the sounds, etc.

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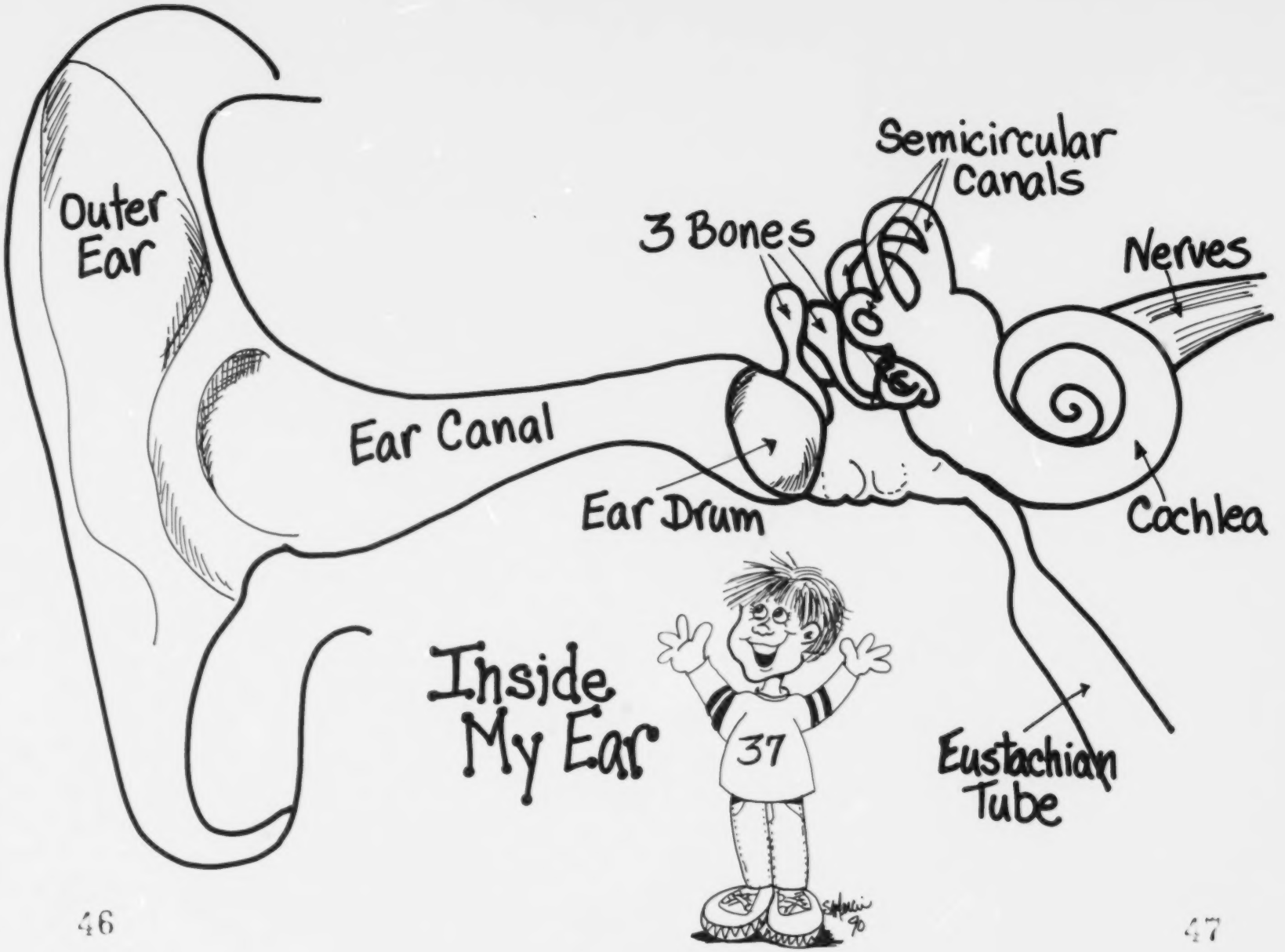

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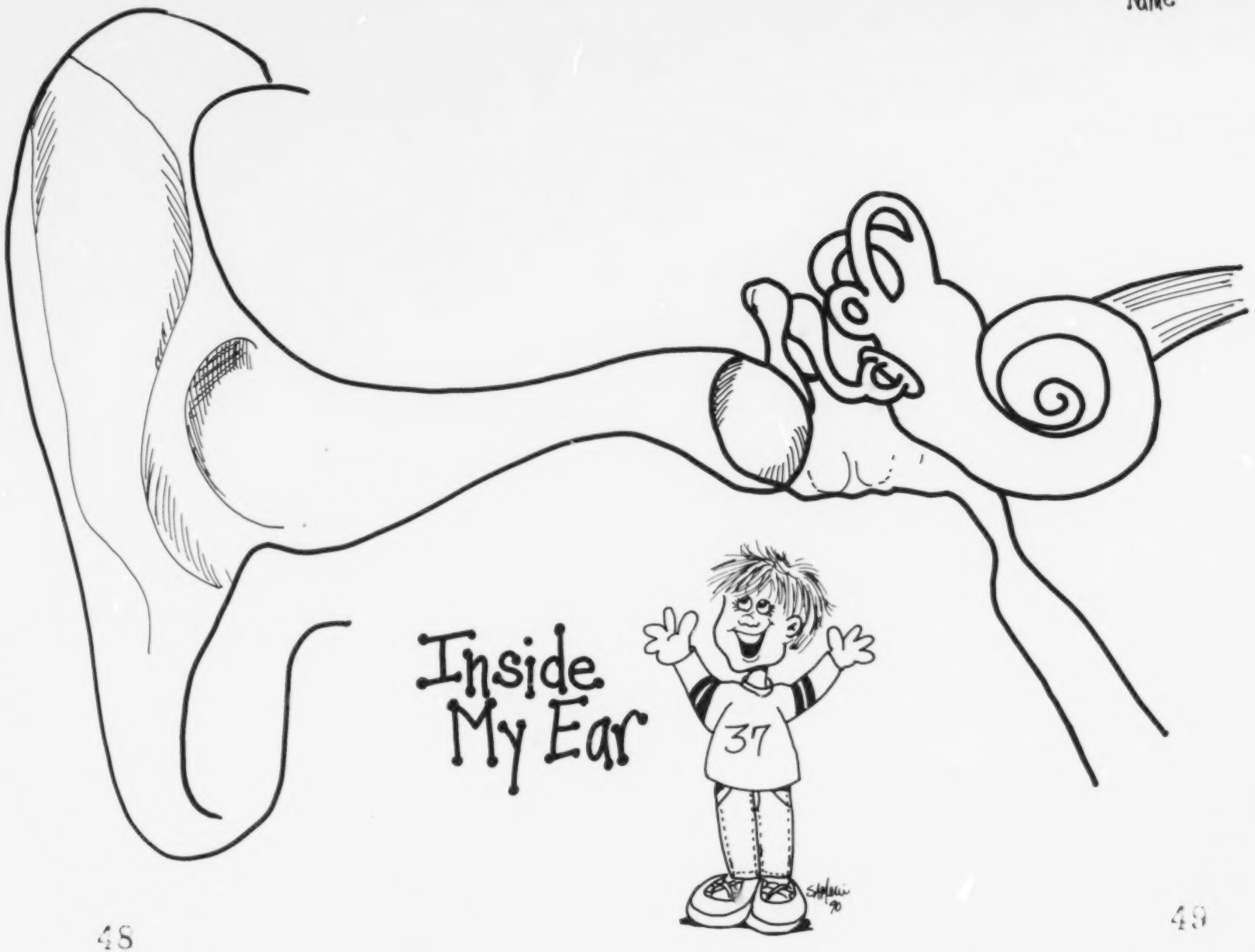
Name _____



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Which Way?

I. Topic Area
Physical Science—Sound Energy

II. Introductory Statement
The students will test to see if two ears are better than one for locating sound.

III. Math Skills
Comparing
Estimating
Problem solving

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing conclusions
Interpreting data

IV. Materials
Noisemakers (pencils to tap on desks, a bell, seeds in a cup)

V. Key Question
Are two ears better than one to locate sounds?

VI. Instructional Information
The sense of hearing involves the ear, the auditory nerve, and a special center within the brain. The outer ear, shaped like a funnel, picks up sound waves and leads them to the ear canal. At the inner end of the ear canal is a thin membrane called the eardrum. As sound waves strike the eardrum, they cause the eardrum to vibrate. The eardrum passes on the vibration to three tiny bones. These three bones carry the vibrations to the inner ear. The inner ear has many small nerves which receive the vibrations. These small nerves connect with the auditory nerve which carries the sound message to the brain.

Our brain uses these messages for locating the direction from which a sound comes. A sound will always reach one ear a fraction of a second sooner than the other. The brain is able to interpret this minute difference. To a certain degree, we also can detect the distance a sound is from us. Because our ears are separated by several inches, the brain is able to compute an approximate distance. Scientists use a triangulation to mathematically calculate distances when using sonar, echo location and other listening devices.

VII. Management Suggestions
1. Have three or four students stand in various parts of the room as noisemakers. Supply them with whatever article you are using to make noise. All should make exactly the same sound.
2. All the rest of the students in the class will be the test subjects. They are to remain seated in their desks and close their eyes.

VIII. Procedure
1. Discuss with the students the function, form, and workings of the human ear.
2. Explain to the students that they are going to do an experiment to see how the ears help us to detect sound direction.
3. Four students should be chosen to be soundmakers, and they should be seated randomly around the room and not bunched in one part of the classroom.
4. The rest of the students are the test subjects and also the record keepers. Instruct these students to shut their eyes and listen carefully to the sound they will hear, and be ready to point in the direction they think the sound originated from. Pass out the worksheet "Which Way?"
5. Begin the test by having one of the soundmakers make a sound. (Whatever noise is chosen should be repeatable. Each soundmaker should make exactly the same sound when it is their turn.)
6. All of the test subjects should then open their eyes and point in the direction from which they think the sound came. The first soundmaker will raise his hand. The test subjects should indicate in their worksheet under both ears whether they were correct or not.
7. Have the test subjects close their eyes again and, the teacher using sign language or another quiet method, picks another soundmaker to make the sound and repeat the test. Randomly pick soundmakers around the room until all have made the sound and five tries have been made.
8. Repeat the whole procedure again, but this time have the test subjects cover their left ear with their hand.

IX. Discussion Questions
1. When was it the hardest for you to point to the soundmaker?
2. When was it the easiest for you to point to the soundmaker?
3. Why are two ears better at detecting direction than one?

X. Extensions
1. Try the test again, but test with one ear first and then with two.
2. A test could be run where the right ear is covered instead of the left.

XI. Subject Integration
1. Invite a health specialist, a school nurse, or a parent to speak to the class about ear care and how to test hearing.

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Which Way?

Name _____

Are two ears better than one to locate sounds?

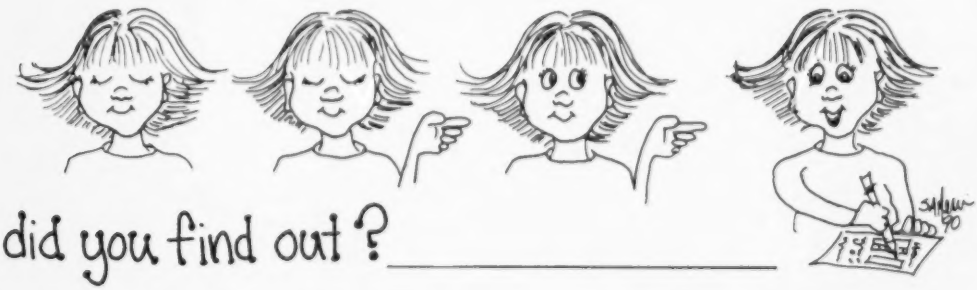
Both Ears

1.	First try	yes	no
2.	Second try	yes	no
3.	Third try	yes	no
4.	Fourth try	yes	no
5.	Fifth try	yes	no

Left Ear Covered

1.	First try	yes	no
2.	Second try	yes	no
3.	Third try	yes	no
4.	Fourth try	yes	no
5.	Fifth try	yes	no

Shut your eyes. Listen for the soundmaker to make the sound. Point in the direction of the sound. Open your eyes and find the soundmaker. Mark each try that you are correct.



What did you find out? _____

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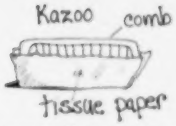
Musical Instruments

I. Topic Area
Physical Science—Sound



II. Introductory Statement
The students will create instruments that they can strike, blow into or pluck.

III. Math Skills
Measuring
Comparing
Estimating
Problem solving

Science Processes
Observing
Communicating
Collecting/Recording data
Classifying

IV. Materials
Various throw-away items (see Instrument Ideas page)
String
Balloons

V. Key Question
What kind of instrument can you create that makes sounds by striking, plucking, or blowing?

VI. Instructional Information
Sound is produced by vibrating objects which make sound waves. Sound waves are a series of compressions and rarefactions in molecules. These waves go out in every direction so that, if you could see them, they would look like concentric, rounded shapes spreading out from the source of the noise. The plucking of the strings of a guitar causes those strings to vibrate. The movement of those strings pushes against the air around them, thus causing the air to vibrate outward from the strings in a wave-like motion. A guitar has a hollow wooden body that acts as a sounding board. When the string vibrates, the wood vibrates at the same frequency. The air inside and outside the wood begins to vibrate so that we can hear the musical note.

All other musical instruments cause similar waves from the vibrations they create. While the guitar causes its vibrations from plucking, other instruments do the same through blowing or striking.

Instruments that produce sound through striking are grouped into the percussion section of a band. Woodwinds make music through blowing, which causes a reed to vibrate. Brass winds, like trumpets, set up a column of air vibrating as the musician blows through them. Strings, as the name implies, have strings to make a sound.

VII. Management Suggestions
1. Send a letter home to parents asking them to save coffee cans, aluminum pie pans, clay flower pots, glass soft drink bottles, rubber bands, spoons, oatmeal boxes and any other items which can be used for band instruments.
2. Make two or three instruments to show to the class.

VIII. Procedure
1. Show the students several of the discard items. Ask them how they think these things could be used to make sounds.
2. Tell them they are going to use "throw away" items to make musical instruments.
3. Brainstorm with the students how various materials could be used to make an instrument.
4. Show the students two or three instruments you have made; have them identify the method by which each is played (blown, struck, or plucked). Play the instruments so the students can hear them.
5. Either in groups or singly, have the students make an instrument of their choice. (See sheet on "How To Construct Musical Instruments")
6. When the instruments are finished, have some students (out of sight of the others) play each instrument one at a time. The rest of the class will try to guess how the sound is made and what material is used to make the instrument.
7. The students can draw a picture (see student sheet "Design An Instrument") of the instrument they made and list what materials were in it. They should also indicate how the sound was made. Students could measure and record dimensions of their instruments.

IX. Discussion Questions
1. Did your instrument sound like you thought it would?
2. What real instrument does your instrument look and sound like?
3. Can you think of any other "throw away" materials that you can use to make an instrument?

X. Extensions
1. Have the students make up their own music to play on their instruments.
2. Bring several actual instruments into the classroom. let the students feel the various instruments as they make sounds. Use a magnifying lens, if necessary, to see the strings vibrate.
3. Create an orchestra. Have all the strings (plucking), percussion (striking), and woodwinds (blowing) sit together. Construct your orchestra by pointing to the section when you want them to sound a note.
4. Read the poem "Orchestra" by Shel Silverstein found in his book *Where the Sidewalk Ends*. Have volunteers act it out.

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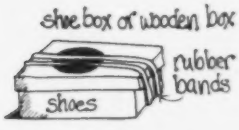
How to Construct Musical Instruments

Plucking Instruments

1. Bass Fiddle
   Use a 2 or 3 pound empty metal coffee can. Turn the can over and punch a hole in the bottom of the can. Thread a heavy string through the hole and make a knot or tie a paper clip on the end so the string won't pull through the hole. Tie the other end of the string around a piece of wood or stick so the string can be pulled taut. Pluck the string to get a bass fiddle sound.

2. Rubber Band
   Hold a rubber band tightly in your teeth and pluck the band. The sound will change as the rubber band is pulled tight or loosened. *CAUTION*—don't let the rubber band snap back and hit you in the face.



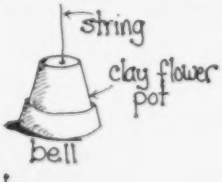
3. Shoe Box Guitar
   Cut a hole in the lid of a shoebox. Stretch different width rubber bands around the box. The narrow bands will have a high sound, the wide bands have a low sound. Pluck the rubber bands to have a guitar sound.

Striking Instruments

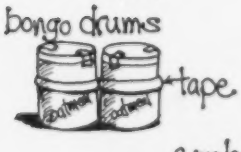
1. Tin Can Drum
   Stretch a balloon over the open end of a coffee can or large tin can. Put a rubber band around the top to hold the balloon tightly over the can. Strike the drum head (balloon) with the eraser end of a pencil.

2. Glass Bottle
   Glass bottles have different pitches depending on how much water is in the bottle. Get several glass bottles and fill with water to different heights. Either strike the bottles with a pencil or blow into the mouth of the bottles.

3. Xylophone
   Make a xylophone by taping together different lengths of copper tubing or sprinkler pipe. Play the instrument by striking the tubing with a pencil or metal rod.



4. Clay Flower Pot
   Clay flower pots have a nice bell tone when struck. Knot a string and thread it through the drainage hole in the pot. Hold the pot by the string and strike with a pencil.



5. Bongo Drums
   Oatmeal boxes can be taped together and used as bongo drums. Strike them with the finger tips. Turn over and strike the closed end of the box.

6. Pie Tin Cymbal
   Aluminum pie tins can be used as cymbals. Hold the pie tin with one hand and strike the bottom of the pan with the other hand.

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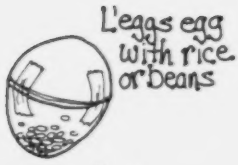
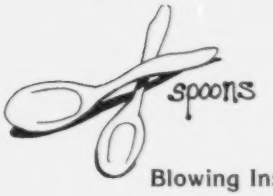


7. L'eggs Egg

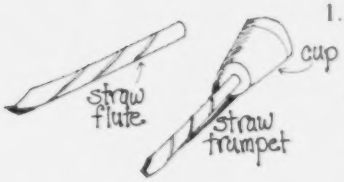
Put some rice, beans or macaroni in a L'eggs egg. Shake the egg or hold in one hand and strike with the other hand.



8. Spoons

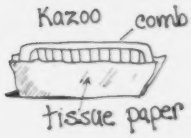
Get two metal spoons. Holding them in two hands, strike the spoons together.

Blowing Instruments



1. Straw Flute and Trumpet

Drinking straws have a flute-like sound when blown into. Flatten the first 5 cm on the straw. Snip off the corners of the flattened end with scissors. The pitch of the flute will depend on the length of the straw. To make a straw trumpet, prepare the straw the same way but insert the straw into the bottom of a paper cup.



2. Comb Kazoo

Wrap tissue paper around a comb. Hold the kazoo up to your lips and hum gently while pursing your lips and letting them vibrate against the paper.

3. Glass bottle

Fill a glass bottle with water to whatever level you wish. Then either blow in the open mouth of the bottle or strike the bottle with a pencil.

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Musical Instrument Ideas

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Name _____

Design an Instrument

You are an instrument designer. Invent a new musical instrument that makes sound by striking, plucking, or blowing.

Draw a picture of your musical instrument. Label its parts.

Write directions for making your instrument.

_____

_____

_____

_____

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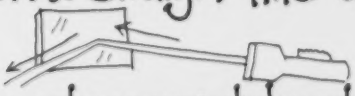
Light Energy

Light is a form of energy. Our primary source of light is the sun. Light energy from the sun travels through space, strikes the earth and is changed to heat energy which warms the air. Without this heat, the earth would quickly become too cold for life. The light from the sun is also stored as energy in green plants. Millions of years ago, plants died and were buried by sediment and became coal, natural gas, and oil. Today, we burn these fuels for energy.

Light can be produced in various ways. Hot materials glow. The light from fire is due to the hot gases in the flame. The sun and stars are masses of intensly hot gas. The light of an electric light bulb comes from tiny, hot, glowing wire.

Light travels in straight lines. For this reason, we cannot see around corners and objects in the path of a light beam cast shadows.

When light strikes an object, it is reflected, absorbed, or it passes through. When light strikes a highly reflective surface such as a mirror, it bounces off in a straight line at the same angle that it hit the mirror.



Objects can be described as transparent, translucent, or opaque. Transparent material allows light to pass through easily. Translucent materials allow some light to pass through and scatters the rest. Opaque materials block or absorb all light.

Light travels at enormous speeds (186,000 miles per sec.). When light passes through transparent substances such as glass, air, or water, it slows down. When light changes speed, its path is changed so that light rays are 'bent' as they pass through. This sudden change in the direction of a light beam is called refraction.

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The Eyes

I. Topic Area
Physical Science—Light—Human Sight

II. Introductory Statement
Students will identify the eye as the organ that sees light. They will be able to state how to care for their eyes.

III. Math Skills
Measuring
Comparing

Science Processes
Observing
Communicating
Collecting/Recording data
Drawing Conclusions

IV. Materials
Small mirrors
Crayons
Hand lens

V. Key Question
How do you see with your eyes?

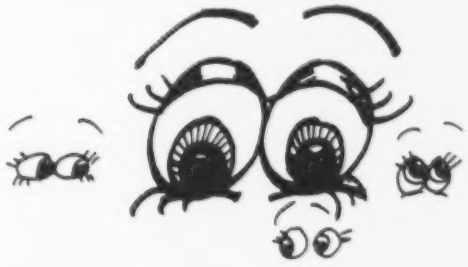
VI. Instructional Information
We are able to see objects by means of reflected light to our eyes. With no light, we are unable to see. The light enters our eyes through an opening called the pupil. The pupil can adjust to the amount of light by expanding and contracting. After the light enters the eye, it passes through a lens which focuses the light on the back of the eye—the retina. The optic nerve picks up the messages from the retina and sends them to the brain.

Our eyes are round balls about 2.5 cm (1 inch) across. The covering or white of the eye is called the sclera. The pupil is protected by the cornea. The cornea helps focus light coming in. The colored part of the eye is called the iris. The iris has muscles which expand and contract the pupil. Each eye has two lids with eyelashes. Eyelashes protect our eyes from dust.

After-image is the term one uses to describe what is seen after one stares at an image or picture for a length of time. This occurs after a portion of the retina becomes fatigued by continued fixed stimuli. If one stares at a black image, the after-image will appear white. If the image is colored, the after-image will take on the complementary color. For example, the image of a red apple when "stared at" will produce an after-image of green. Some traditional colors and their complements are listed here:

IMAGE	AFTER-IMAGE
black	white
red	green
blue	orange
yellow	purple
green	red

VII. Management Suggestions
1. Have the students color the flag before you start the lesson.
2. *Caution* the students to be careful with the mirrors and not to flash light into someone's eyes.



VIII. Procedure
1. Give each child a mirror. Ask them to observe their eyes, carefully. What colors do you see in your eyes? Have the children face the windows or turn toward the lights. Instruct them to cover one eye with their hand, hold it there for a few seconds, then pull their hand away very fast. They should be able to see their pupil contract. Have them draw their eyes on a self-portrait.
2. Identify the parts of the eye. Have the children label the parts with words on the worksheet "Inside My Eye".
3. Give each child a hand lens to look through. Have them hold the lens at arms length. They should notice that everything looks upside down. This is the way your eye "sees" things. Your brain turns the picture right side up.
4. Discuss the proper care of your eyes. Dirt and stress can cause eye infections. Remind the students not to rub their eyes with dirty hands. Looking at bright lights or the sun can permanently damage the eye.
5. Invite the school nurse in to discuss eye care.
6. Fool your eyes! Color a flag; the stripes should be alternating black and green, the stars black on an orange field. Stare at the flag for about one minute, then look at a piece of white paper. The after-image of the flag should be red, white and blue, the complementary colors of black, green and orange.

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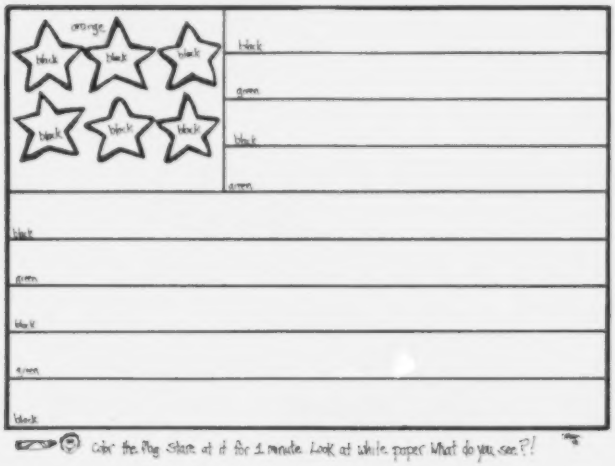
Stare at a large red dot, look at white paper and see green. Stare at a large green dot, look at white paper and see red. Stare at a large violet dot, look at white paper and see yellow. Stare at a large blue dot, look at white paper and see orange. In each case the after-image is the complementary color of the dot's color.

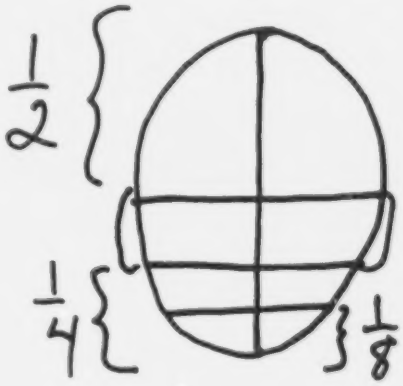
IX. Discussion Questions

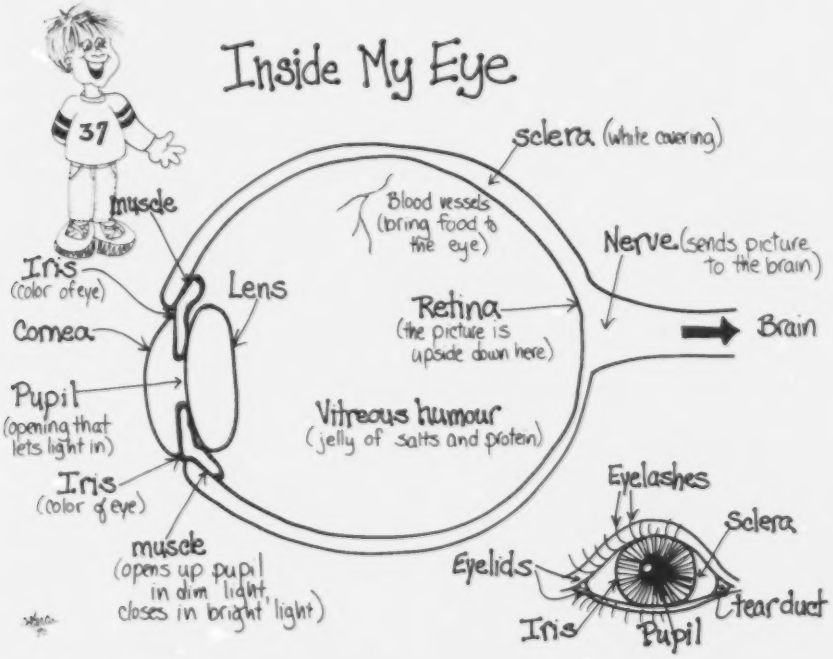
1. Why does the pupil of the eye expand when it is dark or the eye is covered? (the pupil expands to let in more light)
2. Why does the eye see different colors when you look away after staring at certain colors? (We see an after-image. The after-image has the same shape as the original image but different colors. This color vision effect is called successive contrast.)

X. Extension

1. Have the students draw and color some other design. Tell them to stare at it and see if they have an after-image.
2. Students have difficulty placing their eyes on an outline of a face. Have them explore features on their faces by comparing the length of their nose to the width of their eyes, length of ears, width of mouth and even the length of their face. Artists use a proportion method to help them draw the features on faces. Eyes are actually close to the middle of the face 1/2 way between the forehead and chin. The nose is 1/2 way between the eyes and the chin, while the mouth is 1/2 way between the nose and the chin. Ears are lined up with the end of the nose and the top of the eyebrow.







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Name _____

My Eyes

Look in a mirror. Draw and color your eyes.
Finish your face and hair. You are special!

Write 3 sentences about your eyes.

_____

_____

_____

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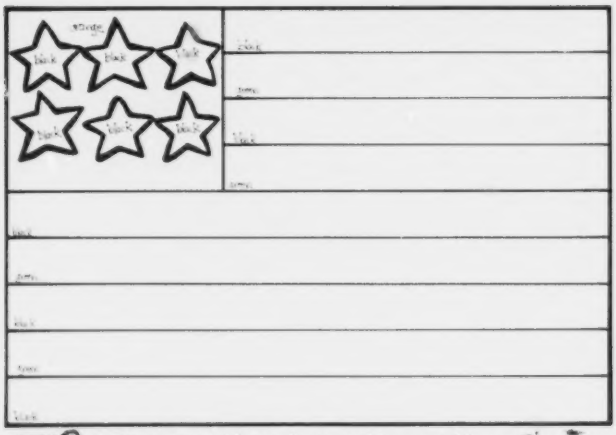

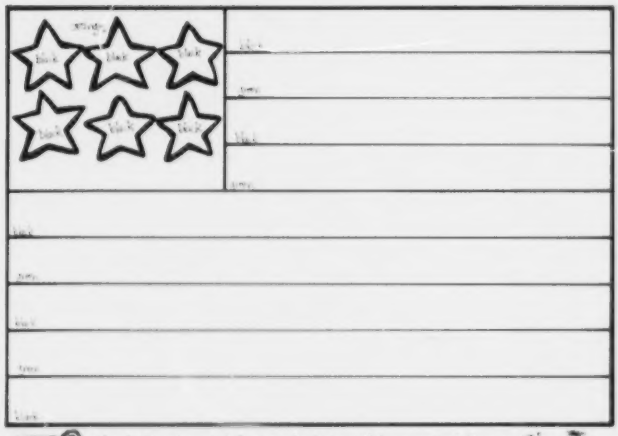

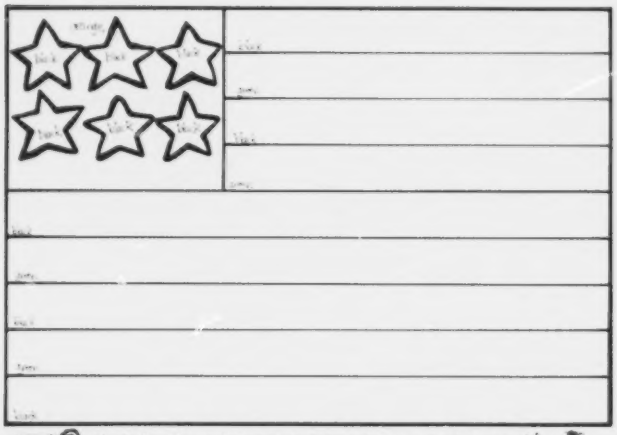

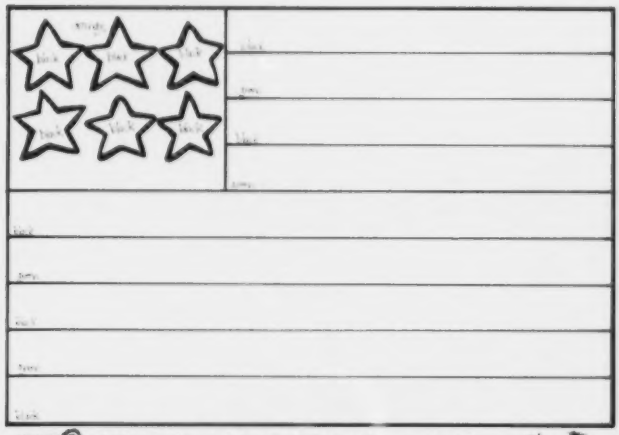

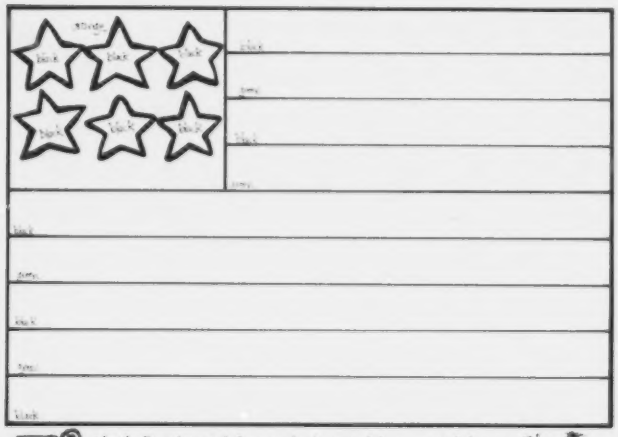

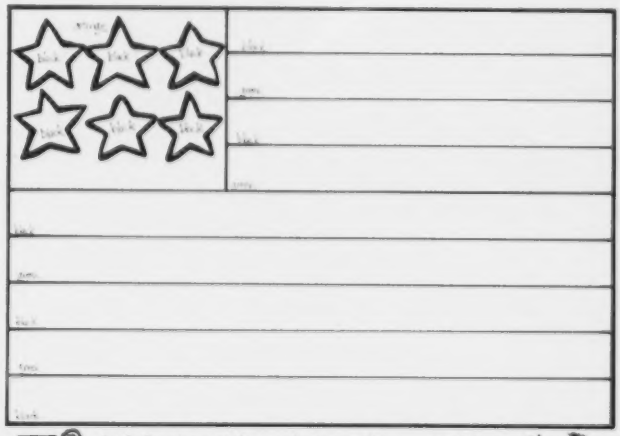

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Inside My Eye

sclera (white covering)

muscle

Blood vessels (bring food to the eye)

Nerve (sends picture to the brain)

Iris (color of eye)

Lens

Retina (the picture is upside down here)

Brain

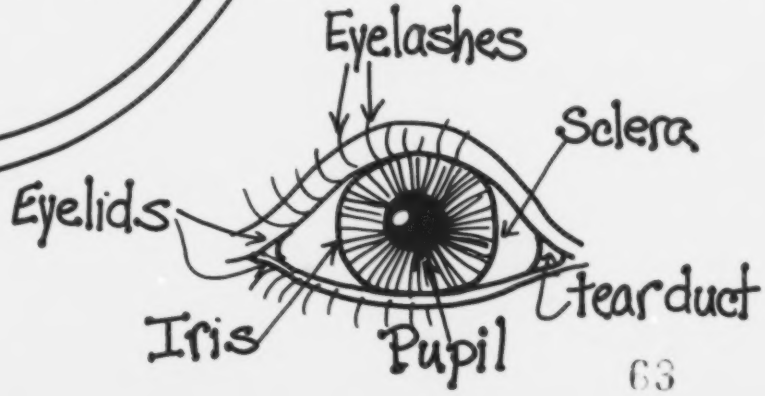
Cornea

Pupil (opening that lets light in)

Vitreous humour (jelly of salts and protein)

Iris (color of eye)

muscle (opens up pupil in dim light, closes in bright light)



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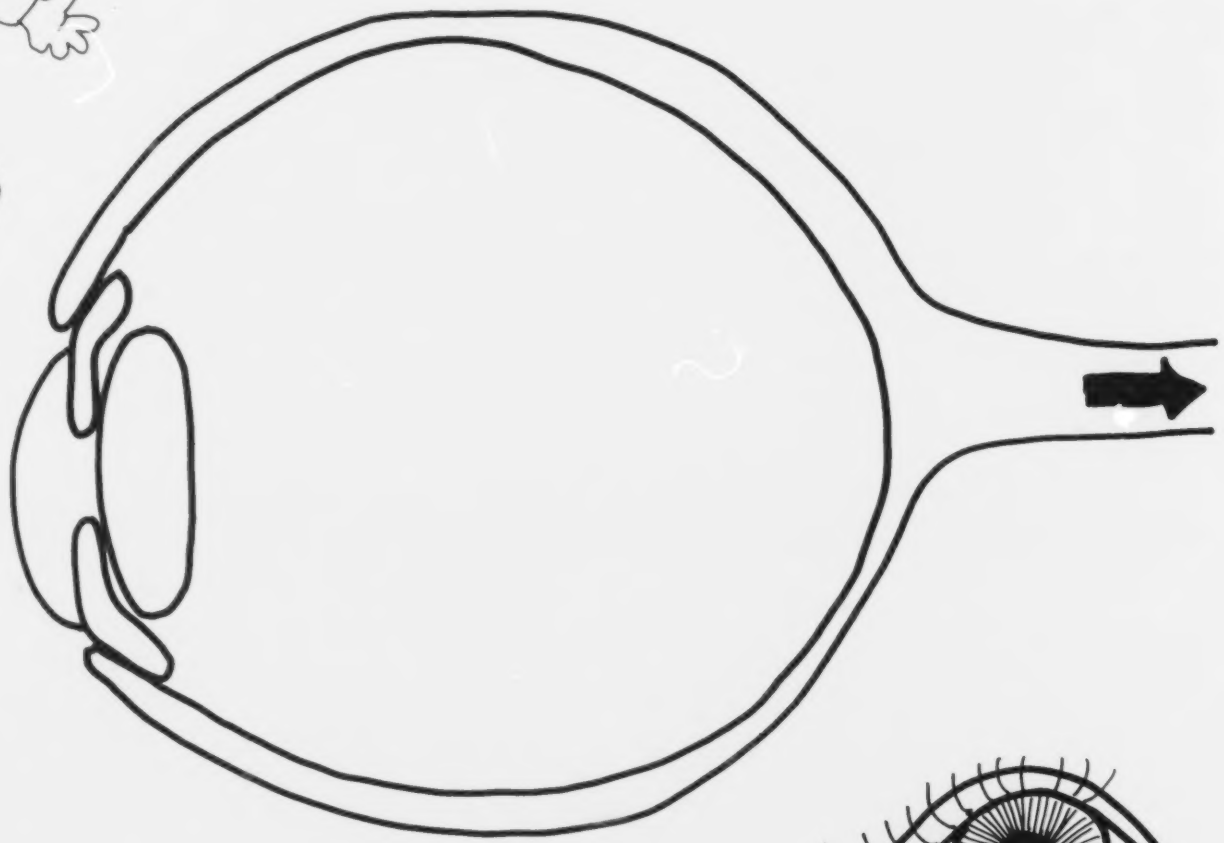
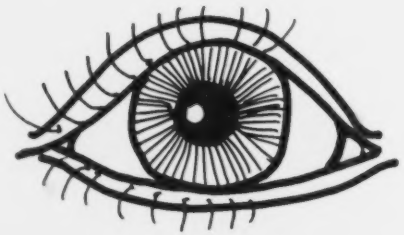
Inside My Eye

Name. _____





Light Sources

I. Topic Area
Physical Science—Light

II. Introductory Statement
The students will investigate many light sources.

III. Math Skills
Comparing
Problem solving

Science Processes
Observing
Communicating
Classifying

IV. Materials
Optional
- Hot plate
- Matches
- Candles
- Flashlight
- Light bulb
- Coleman lantern

Or pictures of things that produce light can be used instead

V. Key Question
What things produce light?

VI. Instructional Information
Light is a form of energy that travels through space. People have learned to make light in order to see when there is no sunlight. Campfires, torches, candles, oil lamps and electricity have all been used to produce light.

The sun is the major source of light for the earth. Sunlight heats the earth. Without this heat, the earth would soon become so cold that nothing could live on it.

Light can be created in various ways. Hot materials glow. The light of fire is due to the hot gasses in the flame. The light of an electric light bulb comes from a hot glowing wire.

VII. Management Suggestions
1. Pictures of light sources can be used instead of the real objects to describe light sources.
2. Pictures of lightning, the aurora borealis and lightning bugs can be used for further sources of light.
3. *CAUTION*—all of the items producing light can become very hot!

VIII. Procedure
1. Discuss with the students that the primary source of light is the sun. All the other sources of light (wood, electricity, gasoline, etc.) had their origins in light from the sun.
2. Brainstorm with the students names of sources of light. (fire, electricity, lightning, sun, flashlight, matches)

3. Ask the students: "What do we use light for?"
4. Have the students look at the following page of pictures of light producing objects. Discuss which ones produce light and which ones reflect light.
5. Cut the pictures apart and paste them in the correct column on the following worksheet.
6. This could be done as a group activity using an overhead projector and transparencies of the worksheets "Light Sources".

IX. Discussion Questions
1. Which picture shows the major source of light? (sun)
2. How many sources of light are pictured?
3. How many pictures show objects which reflect light?

Key

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Light Sources - Cut out the pictures and decide which ones produce light and which ones do not. Glue them down on a chart.

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Name _____

Light Sources

Things that produce light	Things that do not produce light

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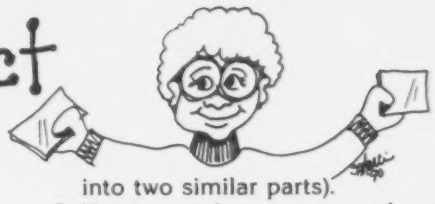
Mirrors Reflect



I. Topic Area
Physical Science—Light Reflection

II. Introductory Statement
Students will use mirrors to show that light travels in a straight line.

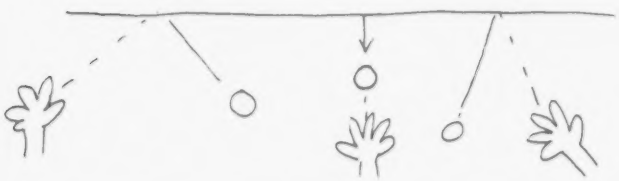
III. Math Skills
Comparing
Problem solving

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing conclusions
Interpreting data

IV. Materials
2 Mirrors per child
Teddy Bear counter or any small object
Student sheets
Crayons or markers
Magazine pictures

V. Key Question
How do mirrors show that light travels in a straight line?

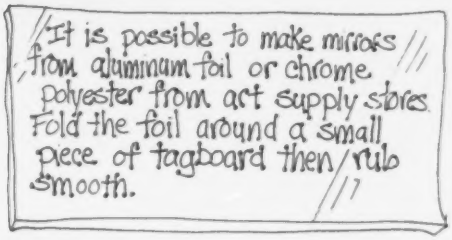
VI. Instructional Information
Light energy always travels in straight lines. When light is reflected from shiny, smooth surfaces, it behaves very much like a bouncing ball.



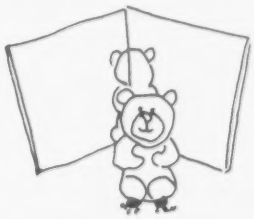
A ball will bounce from a wall at the same angle as it is thrown. Light will bounce off a mirror at the same angle that it hits the mirror.

If you hold a mirror directly in front of you, you will see your own image. As you turn it away from you, you will see different parts of the room. What you see in a mirror is not the same as the object itself. The image is actually reversed. That is why letters and numbers look backward in a mirror. The same is true when you look at yourself in a mirror; your left eye is at the right side of your face, etc. A photograph looks "funny" to you because it is your real image, not a mirror image.

VII. Management Suggestions
1. For procedure #3, tape two mirrors together.
2. Collect colorful magazine pictures—pick some pictures that are symmetrical (can be divided into two similar parts).
3. You can make your own unbreakable mirrors by cutting tagboard or cardboard to the desired size and gluing aluminum foil or mylar to the cardboard.


It is possible to make mirrors from aluminum foil or chrome polyester from art supply stores. Fold the foil around a small piece of tagboard then rub smooth.

VIII. Procedure
1. Give each child a mirror. Have them hold it up level with their eyes. Ask them what they see. (themselves) Instruct them to move the mirror to the side until they can see the person behind them. Can the person behind see your face? (yes) Can you see your own face now? (no) Give the children time to experiment with things around their desks to discover some properties of bouncing light. Make a large chart to record some of their observations. *Caution*—remind students never to flash light in someone's eyes.
2. Hand out the student sheet titled "Mirrors Reflect" and a teddy bear counter (or any other three-dimensional object). Use crayons to color each line as labeled. Place the teddy bear on the small footprints. Have the children place the mirror on the red line behind the bear. They should see the back of the bear. Hand out



another mirror, or team up the children to work as partners. Next, place a mirror on each of the green lines; make sure they touch in the center. They should see three or more images of the bears. Place two mirrors on the blue lines, touching at the center, and they should see no bears. Light travels only in straight lines, and the mirrors cannot pick up the bear's image in this position.
3. Use colorful magazine pages or have the children color geometric designs on the "Kaleidoscope" page. Tape together or hold the mirrors like a book to form a right angle. Lay the magazine picture or kaleidoscope page on the

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table. Hold the taped mirrors on edge on top of the picture. Tip the mirrors back and forth. Move them across the picture for changing effects. Open the mirrors wider or push them closer together.

4. Decode the secret message page by holding a mirror above each word and writing the words below. The message: "Rainbows are red, orange, yellow, green, blue, indigo and violet." Roy G Biv

X. Discussion Questions

1. Why, on the student sheet "Mirrors Reflect", do you see only one bear when the mirrors are on the red line and several bears when the mirrors are on the green line and no bears when the mirrors are on the blue line? (because light travels in a straight line and can not be bent around a corner. On the green line, the mirrors are reflecting light back and forth, making more images)
2. When you look in a mirror, when can you see your own face and someone else's face? (When the other person stands directly behind you.)

XI. Extension

1. Draw or cut out of a magazine halves of objects that can be divided into two similar parts (with symmetry). Samples include: butterflies, faces and vases. Put a mirror next to half of the picture; the image will double to complete the pictures.
2. Try to write your name in mirror writing so that when you look in the mirror you can read it. (Printing is easier.)
3. Write a secret message in mirror writing and give to a friend.

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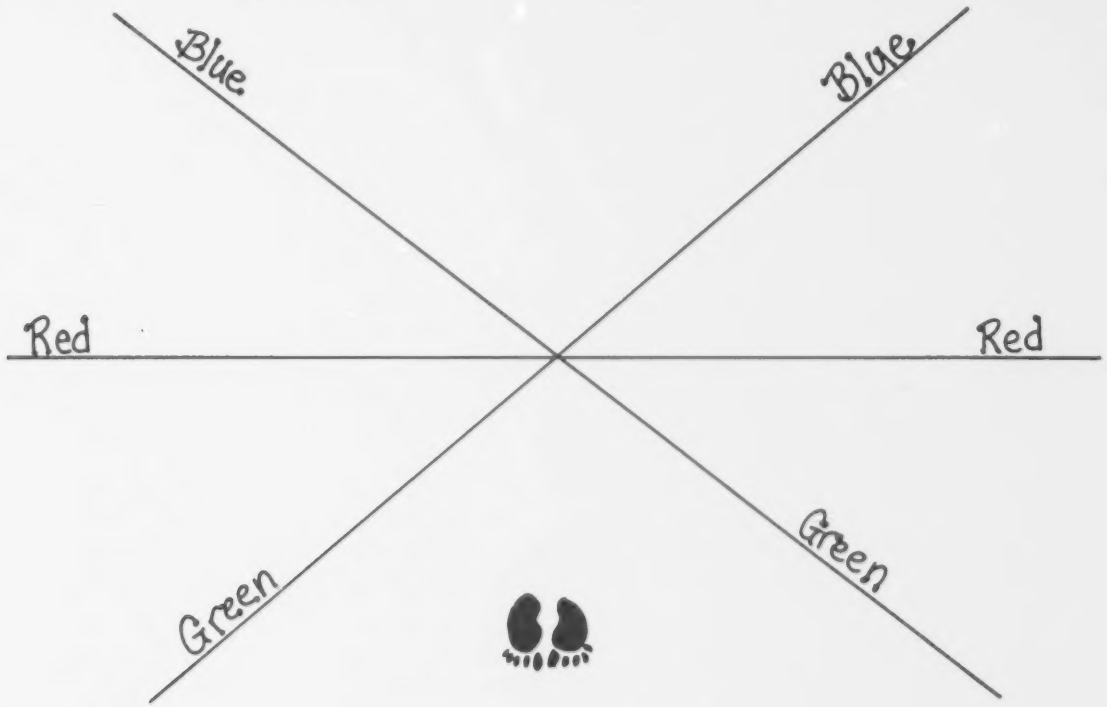
Name _____

Mirrors Reflect

Color the lines. Place an object on the footprints.

1. Put a mirror on the red line.
   What do you see? _____
2. Put a mirror on each green line. Make them touch.
   What do you see? _____
3. Put a mirror on each blue line. Make them touch.
   What do you see? _____



4. Why? _____

_____

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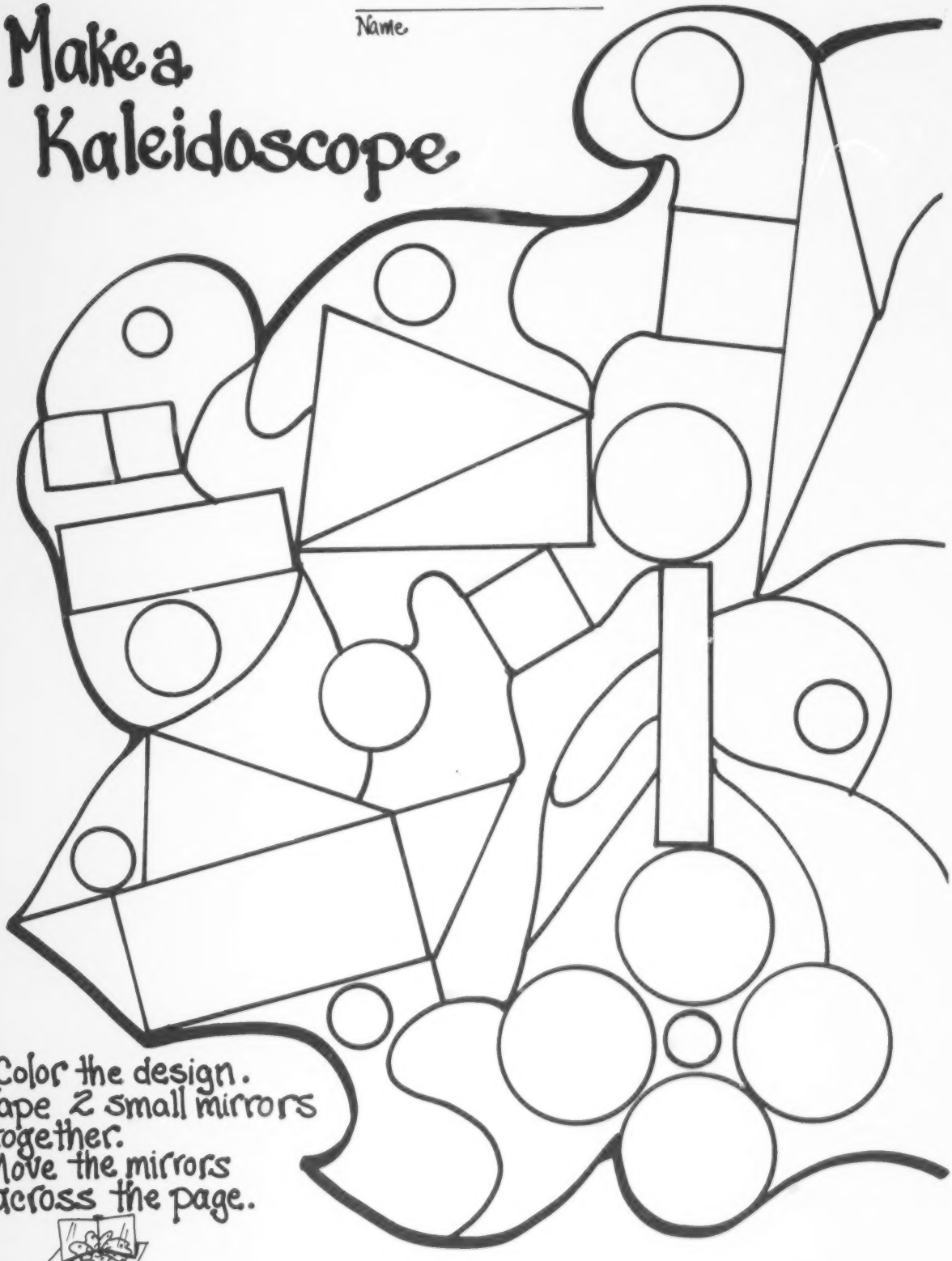
Name _____

Make a Kaleidoscope



1. Color the design.
2. Tape 2 small mirrors together.
3. Move the mirrors across the page.

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My Name _____

Use a mirror to read this secret message.

Rainbows are red, orange,

_____ _____ _____ _____

yellow, green, blue,

_____ _____ _____

indigo, and violet.

_____ _____ _____

ROY G BIV

_ _ _ _ _ _ _

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Just Passing Through

I. Topic Area
Physical Science—Light Energy

II. Introductory Statement
Students will use a flashlight to discover which materials are transparent, translucent or opaque.

III. Math Skills
Measuring
Comparing
Estimating

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Classifying

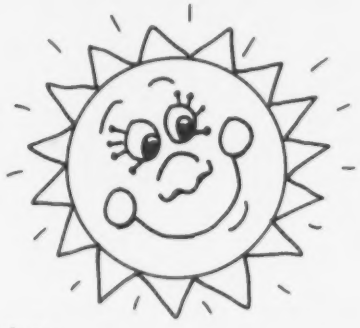
IV. Materials
Light source (sunshine, overhead projector, flashlight, etc.)
A collection of items to test:
Glass jar or window pane
Sheet of white paper
Piece of plastic (transparency film)
Cardboard
Aluminum foil
Waxed paper
Tissue paper
Glass of water
Mirror
Other items that can be used—cloth, book, hand lens, paper plate

V. Key Question
What happens when light strikes these objects?

VI. Background Information
Light comes from a variety of sources, but all sources can be traced to the sun's energy. Light travels in a straight line. When light strikes an object, the object may allow light to pass through, or it may block some of the light, or it may block all of the light. In many cases the object may also reflect light.

Objects can be classified into three categories. A transparent object allows light to pass through easily. A translucent one lets some light pass through but not all and will cast a light shadow. Opaque objects block all light and cast a dark shadow. Some objects with a shiny surface do not allow light to pass through but reflect most of it.

VII. Management Suggestions
1. Gather the objects you wish the students to test. (see materials list)
2. It may be helpful to have small collections of the suggested materials in bags to be used in group settings.
3. It is wise, too, to use flashlights to focus the light source on the object and to darken the room during testing. This makes it easier for students to decide if an object is blocking light or allowing light to pass through.



VIII. Procedure
1. Ask the students to think of all the sources of light that they can. You may want to record their suggestions on a language experience chart shaped like the sun or a giant light bulb. Sources might include lamp, overhead, match, candle, flashlight, nightlight, campfire, moon, glowing coals, television, fluorescent lighting, street lights and, of course, the *sun*.
2. Explain that all these sources of light get their energy from the sun. Electricity is made from the burning of energy stored by plants long ago. Even hydroelectric power is available because the water cycle is powered by the sun. The moon is actually reflected sunlight, so it is not a true producer of light.
3. Ask students if they know how light behaves. Discuss how some objects let light through very easily, such as a window. Other objects block all light, such as a book. Then there are other objects that allow some light to pass through, such as wax paper.
4. Pass out worksheet "Just Passing Through".
5. Distribute the objects you wish the students to test.
6. (This part of the lesson can be done as a whole class activity, or you can put the students in small groups to test each material with a flashlight.) Show the materials one by one. Have the students predict by a show of hands whether the object will be transparent, translucent, or opaque when a light shines on it. Then test each item by holding it up to a light source. If it casts a dark shadow, it is opaque. If the

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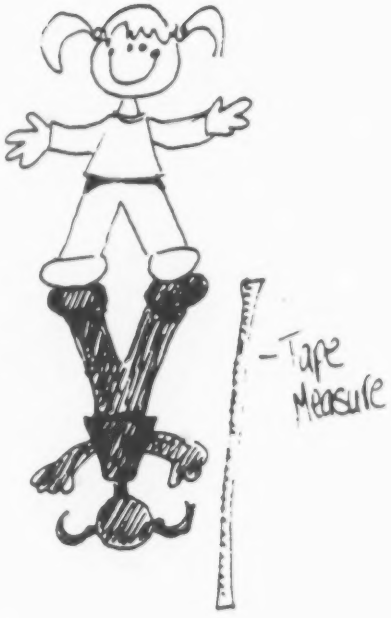
shadow is light, it is translucent. If there is little or no shadow, the object is transparent. If you lay each object on the overhead, the shadows will be projected onto the screen and easily be seen by all.

IX. Discussion Questions

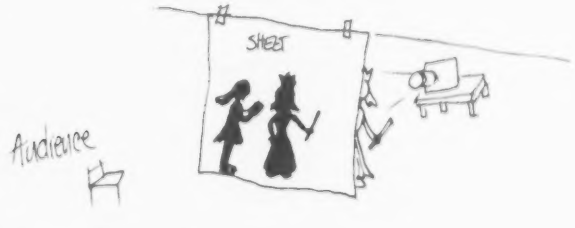
1. Which objects allow light to pass through easily?
2. Which objects block all light? What evidence is there that no light passes through some objects? (a shadow is cast)
3. Which objects did not let light through but also reflected most of the light? (mirror and aluminum foil)

X. Extensions

1. Hold an opaque object close to the light source and observe the shadow (large). Move the object away from the light source and observe the shadow (smaller). Move the source to a different position and observe how the shape of the shadow changes.
2. Use your hands and a flashlight or overhead projector to create shadow pictures on the wall (see Hands-On Shadows).



3. Produce a shadow play. Put up a large sheet. The actors perform their play behind the sheet. Put a light source behind the actors so that their shadows will be projected onto the sheet. The audience seated on the other side will see the shadows only.
4. Use a bright light source (overhead projector). Project a shadow of each student on a sheet of white paper. Cut out the silhouette, trace on black paper and cut out. Glue both images nose to nose for a mirror reflection.
5. Make tissue paper stained glass pictures. Post in the windows for beauty.
6. Play a game of shadow tag. Children are tagged by stepping on their shadows.
7. Measurer shadows of children at 1 or 2 hour intervals. Observe how the length and direction of their shadows change.



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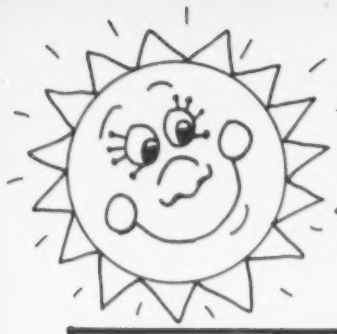
Name _____

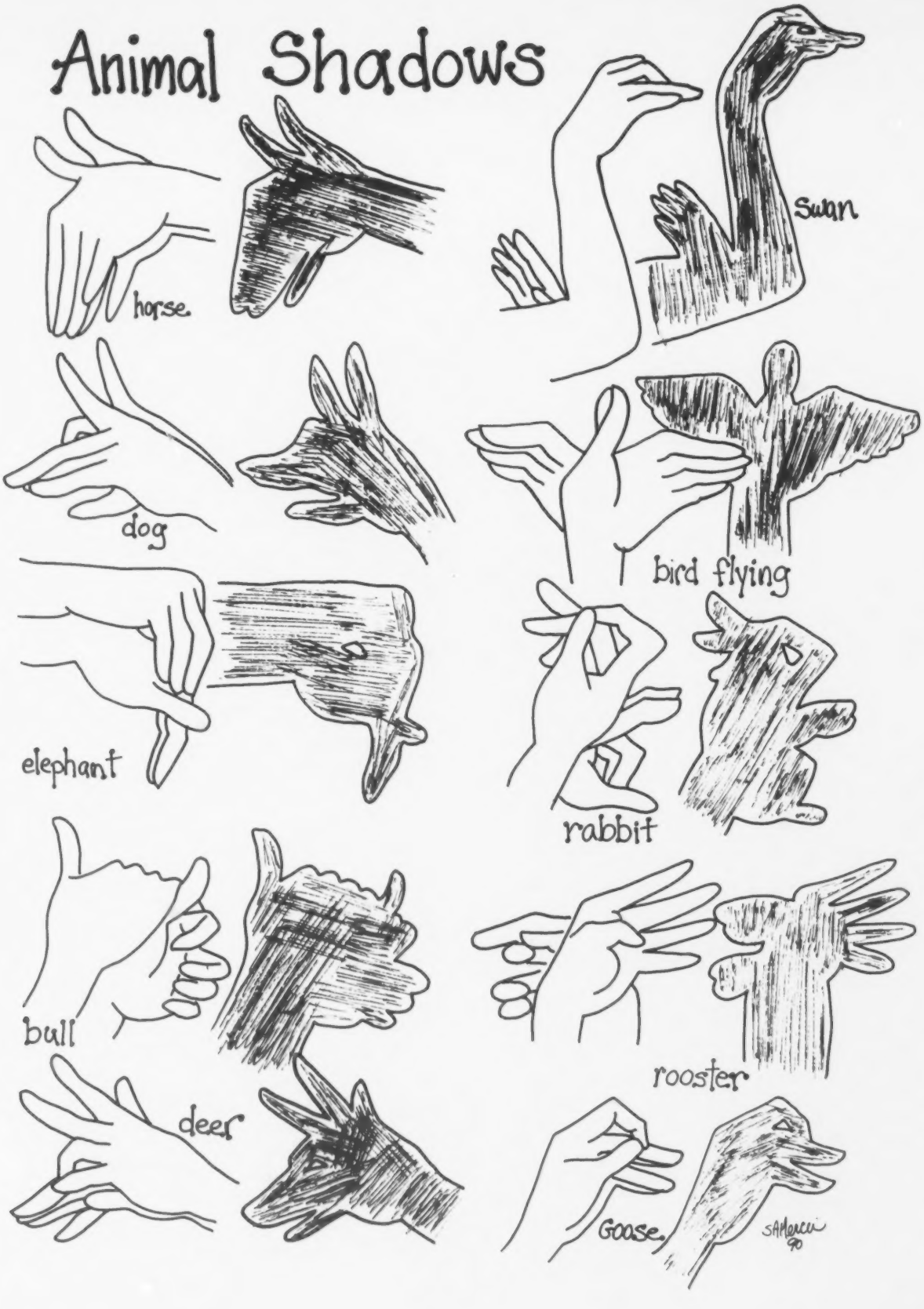


Just Passing Through

What happens when light hits these objects? Will it make a shadow? Test and mark the box.

Name of object	Lets light through	Blocks some light	Blocks all light
glass or			
paper			
plastic			
cardboard			
aluminum foil			
waxed paper			
tissue paper			
water			
mirror			

Animal Shadows



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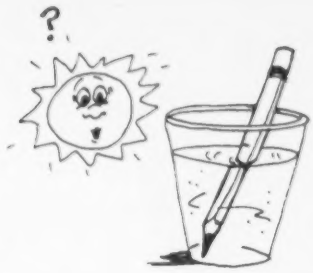
Light Rays Slow Down



I. Topic Area
Physical Science—Light—Refraction

II. Introductory Statement
Students will observe properties of light as it travels through different mediums.

III. Math Skills
Measuring
Comparing
Problem solving

Science Processes
Observing
Communicating
Collecting/Recording data
Drawing conclusions

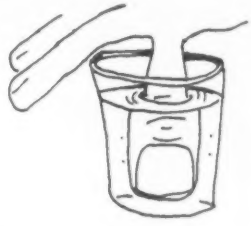
IV. Materials
Clear plastic cup
Pencil
Water
Sticker

V. Key Question
What happens when light travels from one medium to another?

VI. Instructional Information
When light passes through some mediums such as glass or water, it is slowed down (looks bent). This "bending" of light as it passes from air through water is called refraction. Light travels slower through glass and water than it does through air.

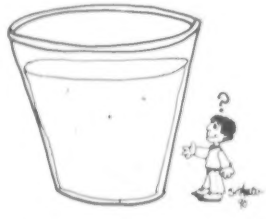
VII. Management Suggestion
Have one student pour water into the cup while the second student observes what happens to the happy face.

VIII. Procedure
1. Give each child (or group of children) a plastic cup, a bright sticker, and the student sheet. Have them color the happy face or cover it with a bright sticker. Instruct them to put the plastic cup on top of the sticker. Make sure they are at about a 45° angle from the cup for viewing. Slowly pour water into the cup until it is 2/3 full and the sticker will look as if it is rising to the top of the cup. Look straight into the cup from above; the sticker is visible, but look from the side—it has disappeared! The reflected light from the sticker cannot cut corners to come out the sides of the cup. You may want to place a small piece of tagboard on top of the cup so that the sticker is invisible from all angles.
2. Next, ask the students to put a pencil inside the cup full of water and to lean it against the side. Have them observe the pencil from above, below, and beside the cup. Have the students draw what they observe. For fun, let them place their thumb into the water—it will look greatly enlarged and distorted.



IX. Discussion Questions
1. What happens to the image of the happy face sticker when you put water in the glass? (it looks like the sticker is rising to the top of the cup)
2. Why can't you see the sticker when you look at it from the side of the glass filled with water? (Light travels in a straight line and the reflected light from the sticker can not bend to go around a corner.)
3. What does a pencil look like in the cup of water? Why? (it is bent, light slows down when it travels through the glass and water, thus distorting the image)

X. Extension
1. Make a list of all the words that rhyme with light: sight, bright, fight, height, kite, might, quite, right, tight, white.



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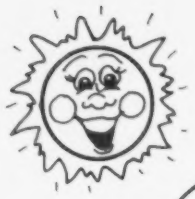


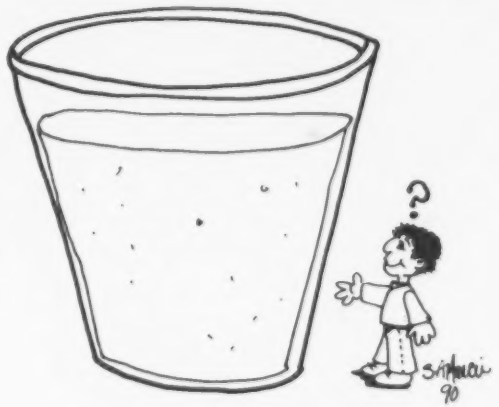
Light Rays Slow Down

1. Color the happy face. Place the empty cup on top of the face.
2. Slowly pour water into the cup.
   What happens? _____
3. Fill the cup 2/3 full. Look through the side of the cup.
   What happens? _____

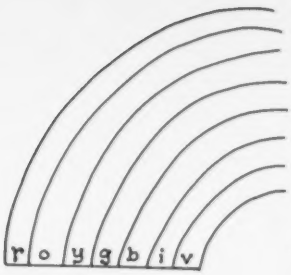
Name _____

1. Place a pencil into a cup of water
2. Move it around.
   What happens? _____

3. Lean the pencil against the side and draw what you see.



I ♥ Color



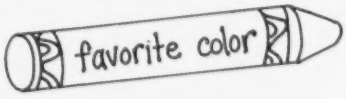
I. Topic Area
Physical Science—Color

II. Introductory Statement
Students will be able to identify colors of the rainbow.

III. Math Skills
Comparing
Graphing
Estimating

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting

IV. Materials
Crayons



V. Key Question
What is the favorite color of the class?

VI. Instructional Information
Color is important in our world. We are delighted with the colors in flowers, in a sunset, in the leaves of autumn and in the brilliant colors of a rainbow.

Color is important in nature. The colors in flowers attract bees to help in pollination, color in fruit attracts fruit-eating animals, the color in some animals helps them attract mates.

Color also serves man as a means of communication. For example, a red traffic light means stop, green go. On a map colors indicate certain things, such as: blue indicates a body of water, black a highway or roads.

Actually, we do not "see" colors; instead we see the light that objects reflect or give off. Green plants absorb all the colors of the spectrum and reflect green to our eyes, white reflects all colors, and black reflects no color.

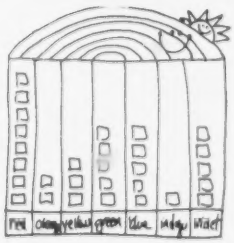
A rainbow is a spectrum formed as white sunlight is refracted by tiny drops of water suspended in the air. Each color has a different wavelength but the same speed. Violet has the shortest wavelength; red has the longest wavelength. They are at opposite ends of the spectrum.

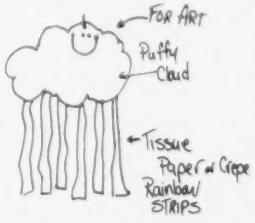
VII. Management Suggestion
Make a large graph on butcher paper, or make a transparency of the "I ♥ Color" graph.

VIII. Procedure
1. Use the student sheets "I ♥ Color". Discuss what colors the children have on that day. How many of them have rainbow colors on?
2. Explain that they will be doing a scientific study of favorite colors.
3. Do the first student sheet "I ♥ Color". Children should write in the colors of the rainbow. Then decide which one is their very favorite color and write that color on their sheets. Ask them not to share their choice with anyone else in the classroom.
4. Next, have them predict which color they think most of the students in the class will pick as their very favorite and record that on their sheet.
5. Collect the papers or have them hide their predictions inside their desks. Make a large rainbow graph of the color choices (or make a transparency of the "I ♥ Color" graph). Let each child come up and put his/her choice of color on the graph. Tension towards the end of the voting may be unbearable, so teach the class how to cheer silently or the two finger clap to express their joy.
6. After the voting is complete, count the numbers for each color and have the class take out their sheets and record the results of the voting on their own papers.
7. To display their data, have the children color in their "I ♥ Color" graphs to match the class graph.

IX. Discussion Questions
1. What was the favorite color of the class?
2. Why do you think that color was the favorite?
3. Which was the least favorite?
4. Were there any tie votes?

X. Extension
1. Make a puffy cloud of cotton or tissue paper and hang tissue or crepe paper from it in the rainbow colors.





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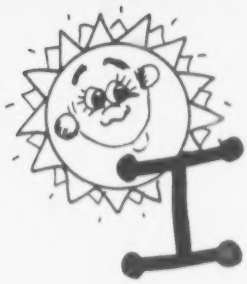
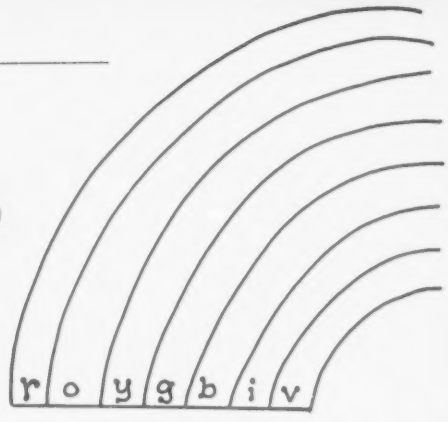
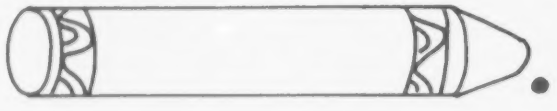
My Name: _____



I ♡ color



1. The colors in a rainbow are r____, o____, y____, g____, b____, i____, v____.

2. My favorite color is  .

3. I think my class will pick the color_____ as their favorite.

4. This is the way my class voted:

red	____
orange	____
yellow	____
green	____
blue	____
indigo	____
violet	____

5. The favorite color of my class was_____.

6. Draw something that makes you think of your favorite color.

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I ♡ Color

My Name _____

My class liked these colors.

	red	orange	yellow	green	blue	indigo	violet
22							
21							
20							
19							
18							
17							
16							
15							
14							
13							
12							
11							
10							
9							
8							
7							
6							
5							
4							
3							
2							
1							

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Magnify

I. Topic Area
Physical Science—Light

II. Introductory Statement
The students will have experience using a magnifying lens.

III. Math Skills
Comparing

Science Processes
Observing
Communicating

IV. Materials
Magnifying lens
Magazine pictures
Leaf
Penny
Pencil

V. Key Question
What does a magnifying lens do?

VI. Background Information
Every day when we look at something, we see through lenses that are a part of our eyes. To see clearly, we may also need to wear eyeglasses, which have lenses. The magnifying glass is a familiar device employing a lens.

A lens is a transparent object, usually made of glass or plastic, with one or two curved surfaces. A lens bends the light going through it. It changes the direction that light moves in; this is called refraction.

A magnifying lens is a lens which makes small objects appear larger. Both sides of the lens are usually curved to form a double convex lens.

VII. Management Suggestion
CAUTION: never let the students look through the lens at the sun.

VIII. Procedure
1. Discuss with the students why magnifying lenses are used (to make small objects appear larger). Ask them who would use these lenses (scientists, biologists, mineralogists, etc.).
2. Let the students experiment with the lens. See if there is anything around them that they can see better when they use a magnifying lens.
3. Encourage them to hold the lens at arm's length and look through it at an object. Gradually bring the lens closer to them until the object is in focus. Ask them what they see. (objects should be upside down)
4. Have the students look at their thumb with the magnifying lens. Draw the print side of the thumb.
5. Tell the students to look at a penny with the magnifying lens. Draw the head side of the coin.
6. Look at a leaf; can you see the veins in the leaf? Draw the leaf.
7. Suggest that they look at their pencil point, cloth fibers, hair, crayon, etc.

IX. Discussion Questions
1. What do you see on the print side of your thumb?
2. What is on both sides of a penny?
3. Describe what a leaf looks like under a magnifying lens.

X. Extensions
1. Try to find lenses of different power magnification.
2. How does a magnifying lens compare to a microscope?
3. What could you do if you were very small or very big?
4. Make a magnifying lens by putting a drop of water on a piece of wax paper. Put the wax paper with the drop of water over some printing. What happens? It should make the printing look bigger. (Try a drop of glycerine, it works a little better.)
5. For a language arts activity, have the children pick something small from around their desk. Then ask them to observe their object carefully with a hand lens. As they observe they should write down words that describe their object. When they are through creating their lists, have them pair up with a student across the room. Students then take turns reading their descriptive words to their partners and have their partners guess what their "secret" objects are.

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Name _____

Magnify

Observe these objects with a magnifying lens. Hold the lens above the object. Slowly bring the lens toward you until the object is in focus.

Draw what you see.

thumb

penny

leaf

Pick a small object. Use your lens to observe it. Write words to describe your object.

Read your list to a partner and have them guess what your mystery object is.

Mystery Object

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Prism Power

I. Topic Area
Physical Science—Colors of the Rainbow

II. Introductory Statement
Students will be able to recognize that white light is made up of the colors red, orange, yellow, green, blue and violet.

III. Math Skills
Comparing
Estimating

Science Processes
Observing
Communicating
Predicting
Drawing conclusions

IV. Materials
Prism
Crayons
Glass pie pan
Overhead projector
Colored cellophane (red, green, blue, yellow)
Construction paper (or tagboard)

V. Key Question
How can white light be changed into the colors of the rainbow?

VI. Instructional Information
Sir Isaac Newton did many experiments with light around the year 1700. He was the first to understand that white light is a combination of all the colors of the rainbow and every shade in between. He concluded that objects had their color because they reflect that color better than others.

Newton sat in a dark room where a ray of sunshine came in through a small hole in a curtain. He then put a small wedge of glass into the path of the light beam. The light was white as it entered the glass. Newton then put a screen with a hole in it behind the wedge so that he could move the screen and allow only one color at a time to pass through. He observed colored objects in the separate beams of colors.

Newton concluded that an apple looks red to us because it reflects red light better than others; the other colors are absorbed by a red apple. A green leaf reflects green more strongly than the other colors, so we only notice the green. White is the mixture of all colors and black is the sensation we get when no light is reflected.

All the colors in white light travel at the same speed, but have different amounts of energy. When a light beam strikes glass or water, it suddenly changes directions. This is called refraction. Each color has a different wavelength and is bent so that the colors separate. Violet has the least energy and the shortest wavelength, while red has the most energy and the longest wavelength. They are at opposite ends of the spectrum.

VIII. Procedure
1. Use a prism to demonstrate how it breaks white light into the colors of the spectrum. Use the prism as an eyepiece and show the students how to hold the prism up to their eyes and look through it at the light. *CAUTION:* never let the students look at the sun through the prism.
2. Give the students the sheet called Prism Power. Darken the room and turn on your light source. What is the color of the light? (white). Explain that they are to look through a piece of glass (or lucite) called a prism at white light. Have them predict what they think will happen to the light. Discuss their ideas.
3. Turn the light on and have the students look through the prism and identify the colors of the spectrum. Have the students record the names of the colors on the rays. Then color (or paint with watercolors) the sheet to match.
4. Place a clear round dish or a drinking glass on the overhead projector. Tell the class that you are going to pour water into the dish (or glass). Discuss what they think they will see.
5. Pour the water in slowly for a dramatic effect. Hopefully, there will be a rainbow all the way around the edge of the glass or bowl. Explain that water can also break light into the rainbow colors.
6. Use an eyedropper (or your finger) to drip a few drops of water directly onto the glass of the overhead. You should be able to see small rainbows around each tiny drop.
7. Have the students wear the goggles or look through the color paddle. What colors seem to be missing? Are the same colors missing with each different color of cellophane?
8. Look through a prism with the colored goggles on. Does the rainbow look different?

VII. Management Suggestion
Make the goggles and color paddle with several different colors of cellophane.

IX. Discussion Questions
1. Name the colors you can see in a rainbow.
2. What difference do you see in the colors when looking at sunlight and at electric or fluorescent lights with a prism?
3. How can you make a rainbow when sunlight shines through water?

X. Extensions
1. Try making a rainbow by putting a mirror in a glass of water and reflecting sunlight off the mirror through the water.
2. Make a rainbow by spraying water in the sunlight. Each drop of water acts as a prism.
3. Discuss what makes a rainbow in nature. Why are there at times a double rainbow?

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Name _____

Prism Power

Color to match what you observe.

White light is made of colors mixed together. A prism shows us the colors in light.

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Goggles

cut out and add colored cellophane.

cut out and add colored cellophane

Cut the goggle pattern from tagboard.

Have students wear goggles of colors and look at colored objects.

Color Paddle.

Cut 6 of the frames from tagboard. Then cut circles of colored cellophane slightly larger than this circle (red, blue, green). Sandwich a cellophane circle between 2 frames and staple. Add a popcicle stick or tongue depressor to the handle for stability. Observe colored paper, each other, and the world through the paddles. Overlap to make new colors.

SAMercier 90

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Heat Energy

Heat is a form of energy whose source is the motion of molecules. When matter is heated, energy is added and the molecules move more rapidly and farther apart. The heated substance expands. This includes all states of matter: solids, liquids, and gases.

When matter cools (loses its heat energy), molecules move slower and can be packed closer together. Cooled substances shrink and become smaller.

Anything that gives off heat is a source of heat. The heat we use on earth comes from several sources.

1. The sun is our most important source of heat. The light energy from the sun strikes matter on earth. This energy causes the molecules to move more rapidly giving off heat. The heat from land and water warms the air and sustains life on earth.

2. Fire is one of the most useful and easily controlled sources of heat. Wood, natural gas, and oil when burning combine with oxygen in the air and produce heat.
3. Friction produces heat when one object rubs against another. Friction is usually an unwanted source of heat for it may damage objects.

4. Nuclear energy can produce great quantities of heat. In a reactor, heat can be produced from nuclear energy slowly enough to generate electricity.

5. The earth contains heat deep inside. People have begun to make use of the earth's heat through geysers to generate electricity.

Heat is a form of energy used by all living things. Plants and animals use heat from the sun. Humans use heat for cooking foods, providing light, powering machines, running automobiles, drying clothes, and providing comfort.

Heat is transfered by three methods: radiation, where heat is traveling by waves from the source; convection, where air is heated, expands and rises, transferring heat throughout an area; conduction, where the heat travels through solids such as metals.

SAdams '90

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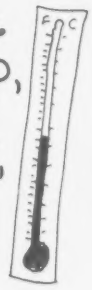
Heat Energy & Temperature

Heat and temperature are related but are not the same thing. Most people are familiar with the idea of temperature. The temperature of our bodies is important to health, recipes tell us the temperature of the air in the oven for baking, the weather report gives us the temperature of today's weather. Our experience tells as that the warmer something feels, the higher the temperature is likely to be.

Temperature is the measure of heat energy. A thermometer is an instrument whose size, shape, or some feature changes when its temperature changes so that it can be used to measure temperature. The most common thermometer is one that has an expanding column of mercury or alcohol. A thermostat has a bimetal strip that expands and contracts to measure temperature.



Heat flows from warmer to cooler. If two objects are put into contact, and we wait until all changes stop, the objects will be at the same temperature. If we put the end of a thermometer in our mouths, heat will flow from our mouths to the thermometer and it will come to the same temperature as our bodies. If a thermometer is left in a room, it will come to the same temperature as the air. No matter where we put the thermometer, in ice water or boiling soup, the energy will flow in or out and make the thermometer the same temperature as the substance it touches.

There are ways to set the scale on a thermometer. The scale that most scientists use is called Celsius, the one we use everyday is Fahrenheit. The thermometer is first put into melting ice where the freezing point is marked 0° Celsius 32° Fahrenheit. Then it is put into boiling water and marked 100° Celsius, 212° Fahrenheit. By making measured marks in between, the thermometer is scaled.

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What is Hot and What is Cold?

I. Topic Area
Physical Science—Heat

II. Introductory Statement
The students will learn what the terms hot and cold mean.

III. Math Skills
Measuring
Comparing
Problem solving
Venn diagram

Science Processes
Observing
Communicating
Collecting/Recording data
Classifying

IV. Materials
Scissors
Worksheet
Large chart

V. Key Question
What do the terms hot and cold mean?

VI. Instructional Information
Heat is a form of energy used by all living things. Plants and animals use heat derived from the sun. Humans use heat for many things—cooking food, providing light, powering machinery, running automobiles, drying clothes, and providing human comfort.

Cold means that heat has been removed. The molecules are moving slower. Humans use the cold to make ice cream, preserve foods, cool houses and buildings.

VII. Management Suggestions
1. Have some items that are hot (a metal object that has been out in the sun) and some that are cold (an ice cube).
2. *CAUTION* the students to be very careful when they touch things that are very hot or very cold.

VIII. Procedure
1. Discuss with the students what is hot and what is cold. Have several objects that feel hot and some that feel cold. Let the students feel them.
2. Ask: Is it cold today? or hot? How do you know without a thermometer?
3. Brainstorm different words to describe the temperature of things—hot, cold, freezing, boiling, warm, cool, and icy. Record on a large chart.
4. Ask the students what foods they eat warm (soup, hamburgers), foods they eat cold (soft drinks, ice cream), foods they eat at room temperatures (chips, cookies).
5. Show the students the worksheet of pictures of things that are hot and things that are cold. Tell them they are going to sort them and put them into the two columns, Hot and Cold.
6. Have the students cut pictures apart and lay them on the worksheet. Discuss with the students where the pictures should be placed and then glue them.

IX. Discussion Questions
1. Have the students explain why they put each picture where they did on the worksheet.

X. Extensions
1. Use cutout pictures to make a Venn diagram. What things are always hot, what things are always cold, and what things can be either hot or cold.

Key

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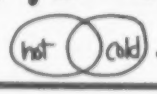
What is Hot and What is Cold?

Cut out and place on a chart

or 
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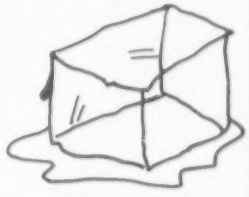
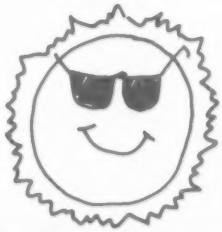
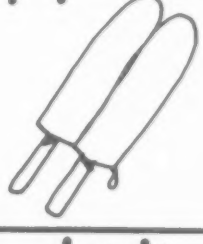
volcano	water	soup	ice cube 
ice cream	flame	snow	girl
chocolate	refrigerator	fire	milk
sun 	ice berg	popsicle 	match
boy	stove	drink	bulb

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Name _____

What is Hot and What is Cold?

Cold

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Heat from Friction

I. Topic Area
Physical Science—Heat Energy

II. Introductory Statement
Students will realize that rubbing two surfaces together produces heat energy.

III. Math Skills
Comparing

Science Processes
Observing
Communicating

IV. Materials
None needed

V. Key Question
Can rubbing two objects together produce heat?

VI. Instructional Information
Heat can be produced by friction. Two objects when rubbed together cause friction, a speeding up of the molecules and atoms in the objects. Friction is the force that opposes motion. Friction always changes work to heat. If you rub your hands together, you can feel heat caused by friction.

Materials with rough surfaces can create more friction and resulting heat than those with smooth surfaces. However, friction can be produced on smooth surfaces by rubbing them rapidly for a long time, but it will take much longer than with rough surfaces and the resulting heat will be much less.

VII. Management Suggestions
None

VIII. Procedure
1. Put the word "friction" on the board and discuss with the students that friction occurs when two objects are rubbed together. Heat energy is produced by the friction.
2. Tell the students to put their hands on their face. Have the students discuss how their hands feel.
3. Now tell the students to press the palms of their hands together. Tell them to rub their hands together fast and hard while they count to 30. Then put their hands on their face again. Ask them how their hands feel now. Why? (They will be warmer because the friction between the hands create heat energy.)
4. Let the students' hands "cool off" and then repeat the experiment. Do they get the same results?
5. Have the students rub their hands over their desk tops to get the same heat from friction.
6. Coats, sweaters, and books are other mediums the students can be encouraged to rub their hands across. Each time they should place their hands on their face.

IX. Discussion Questions
1. What is friction?
2. Are you creating friction when you rub your hands together?
3. How is friction used to stop motion?
4. Does it make a difference in the amount of heat produced if you rub your hands fast? or slow?
5. Why do we need friction? (without friction we could not walk—it would be like walking on ice.)

X. Extension
1. Rubbing two inflated balloons together will create friction and heat. One balloon will eventually pop. Ask the students why rubbing the balloons together made one pop. (Because the friction between the two balloons made one balloon so hot that part of it melted.)
2. Try rubbing two sheets of fine sandpaper together. There will be enough heat produced that you will not want to put your hands on them.
3. Friction is often unwanted heat energy. Explain that machines with moving parts encounter friction when parts touch. Oil is added to reduce friction. Have the students repeat the "Heat From Friction" activity with lotion on their hands. How do the results differ?

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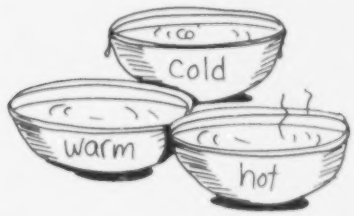
HOT or COLD?

I. Topic Area
Physical Science—Heat—Skin Sensors

II. Introductory Statement
Students will observe that the skin is not always a reliable sensor of temperature.

III. Math Skills
Measuring
Comparing
Timing

Science Processes
Observing
Communicating
Predicting
Drawing conclusions
Interpreting data



IV. Materials
Hot and cold water
Three bowls
Paper towels

V. Key Question
Is it possible for the skin to reliably sense heat and cold temperatures?

VI. Instructional Information
The skin is one of the five main sense organs. The skin has five special skin senses; they are touch, pressure, heat, cold and pain. The sense of touch tells if things are rough, smooth, hard or soft. Messages are carried from the skin through nerves to the brain.

The skin senses heat and cold and reacts to it. When it becomes cold, the blood vessels in the skin will become smaller. Thus, less blood is able to enter the blood vessels of the skin. More heat is kept inside the body.

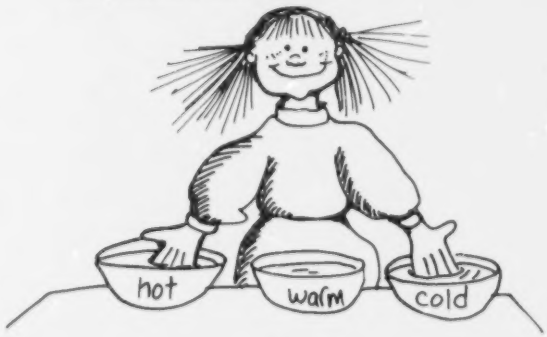
When it becomes warm, tiny blood vessels in the skin get larger. More blood is able to flow into these blood vessels. More heat from the blood passes from the blood into the air and the body is cooled.

The skin adapts to many sensations that are sent to it.

VII. Management Suggestions
1. Be sure the three bowls have water that is at three distinct temperatures, cold, warm (room temperature), and hot. *CAUTION:* don't make the hot water too hot to touch.
2. Discuss the sense of touch with the students.

VIII. Procedure
1. Discuss what sense organ is involved in feeling hot or cold temperatures.
2. Ask the students to describe what hot and cold means to them. Encourage them to use descriptive adjectives to explain the differences in temperatures.
3. Ask the students if water can be hot and cold at the same time?
4. Set out the three bowls.
5. Pour cold water into one bowl, hot water into another, and lukewarm water into the third.
6. Have a student put one hand in the hot water and one hand in the cold water. Leave them there for two minutes.
7. Put the hand that is in the hot water into the lukewarm water. How does it feel—hot, cold or lukewarm?
8. Put the hand from the cold water into the lukewarm water. Does the water feel the same as it did with the other hand?
9. Use a thermometer to measure the temperature of the three bowls of water. Compare.

IX. Discussion Questions
1. Could the same experiment be done with a different medium such as metal? Would the results be the same?
2. How much did the temperature of the three bowls differ? Did your skin feel the same temperature differences?



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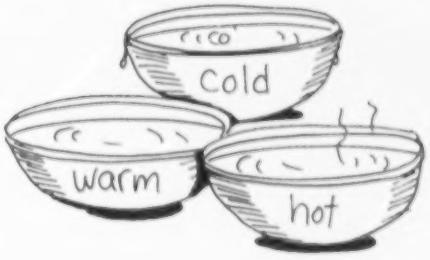
Name _____

HOT or COLD?

You will need:

3 bowls
cold water
hot water (not too hot)
warm water



Do This:

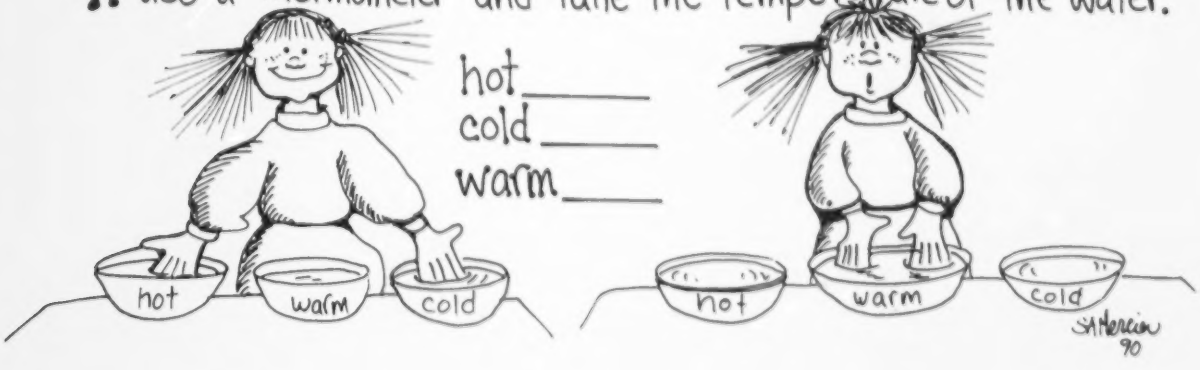
1. Pour cold water into one bowl, warm water into another bowl, and hot water into the third bowl.

2. Put one hand in the bowl of cold water. Put the other hand in the bowl of hot water.

3. Take your hands out and place them both in the bowl of warm water.

4. Use a thermometer and take the temperature of the water.

hot_____
cold_____
warm_____



What did you feel when you put both hands in the warm water? _____

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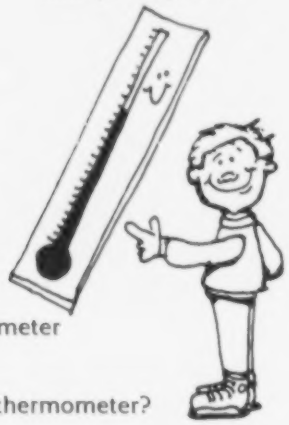
What is the Temperature?

I. Topic Area
Physical Science—Reading a Thermometer

II. Introductory Statement
The students will learn how to read a thermometer.

III. Math Skills
Measuring
Comparing
Graphing
Timing

Science Processes
Observing
Communicating
Collecting/Recording data
Interpreting data



IV. Materials
3 thermometers
Crayons
Bulletin board thermometer

V. Key Question
How do you read a thermometer?

VI. Instructional Information
A thermometer is an instrument for measuring temperature. Temperature tells us how much heat energy something has.

Heat is measured in degrees, and a thermometer tells us how many degrees of heat something has.

The boiling point of water is 212 °F (100 °C) and the freezing temperature is 32 °F (0 °C).

The most common kind of thermometer is a thin closed tube of glass. At the bottom of the tube is a small bulb. This contains a supply of mercury or alcohol. Heat from the substance being measured makes the liquid inside the tube expand. The expanding liquid rises inside the tube. As the air cools, the liquid contracts and falls.

VII. Management Suggestions
1. The large thermometer should be pieced together and posted on the bulletin board.
2. The students should be shown how to hold a thermometer. *Caution* the students that the thermometers are glass and can be broken.
3. Choose whether you will teach Celsius or Fahrenheit. If both are done at the same time, it is confusing.
4. *Teachers—before printing student sheet, mark the degrees in Celsius or Fahrenheit.*
5. *On the large Bulletin Board thermometer, if you live in an area where the temperatures will get below 0°, you will need to cut the bulb off the thermometer and slip in the page showing temperatures below 0°, then add the bulb at the bottom of the page.*

VIII. Procedure
1. Get a thermometer and have the students make observations.
2. Show the students that the top of the liquid indicates the temperature.

3. Have the students read the numbers actually appearing on the scale.
4. How many degrees does each line on the thermometer show?
5. What is the highest temperature reading on the thermometer?
6. What is the lowest temperature reading on the thermometer?
7. The teacher should model reading the correct temperature.
8. Then the students will take their thermometers to find the temperature in these three areas:
   a. Inside the room away from all sources of heat for 5 minutes.
   b. Outside the room in the shade for 5 minutes.
   c. Your body (hold in your fist for 5 minutes).
9. Make the large thermometer as shown. The teacher should record the temperature of the three areas on the large thermometer in front of the room. Have the students color their worksheets from their findings.

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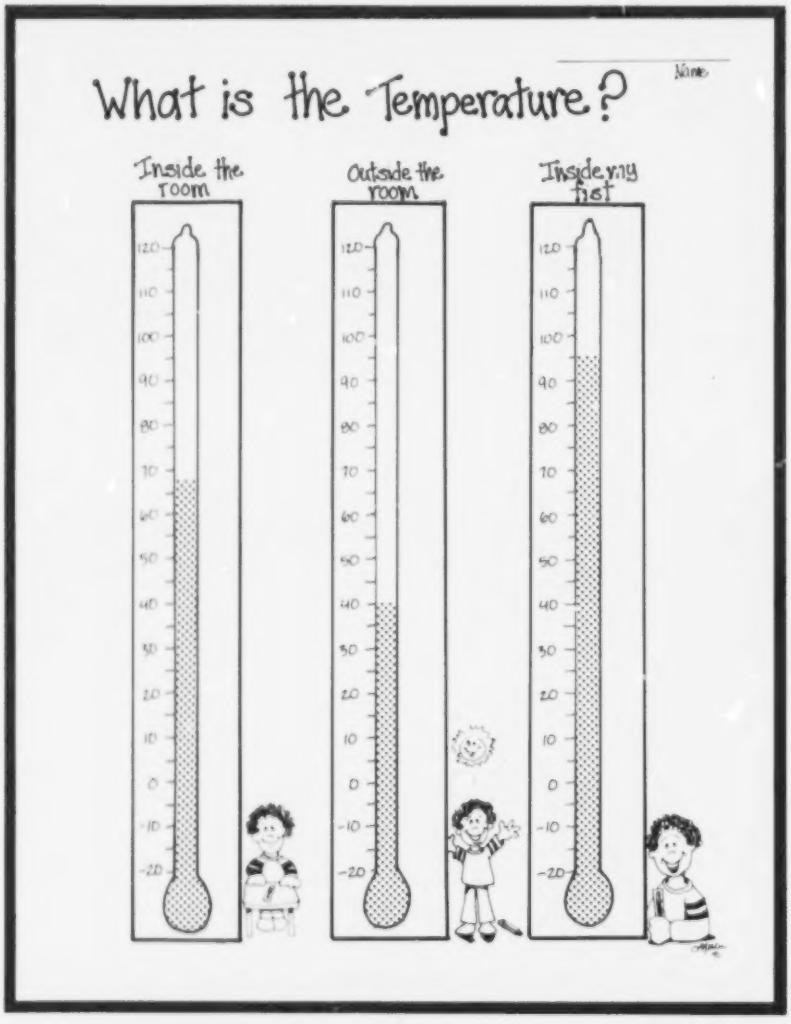
IX. Discussion Questions

1. Discuss the uses of the thermometer in the home, in the school, and elsewhere in the community.
2. Discuss why it is necessary to use a thermometer to find the temperature and the ways its use affects our daily lives. (Remember the Weather Bureau, farmer, airlines, etc.)
3. Discuss what the liquid in the thermometer is and that when liquid is heated it expands and goes up the tube.
4. Do the thermometers of all the students register the same temperature? If not, why is there a difference?

X. Extension

1. Make a thermometer with the make it sheet. The key to success in this activity is to make the clay seal air tight. It works best if you bring clay over the top of the bottle.



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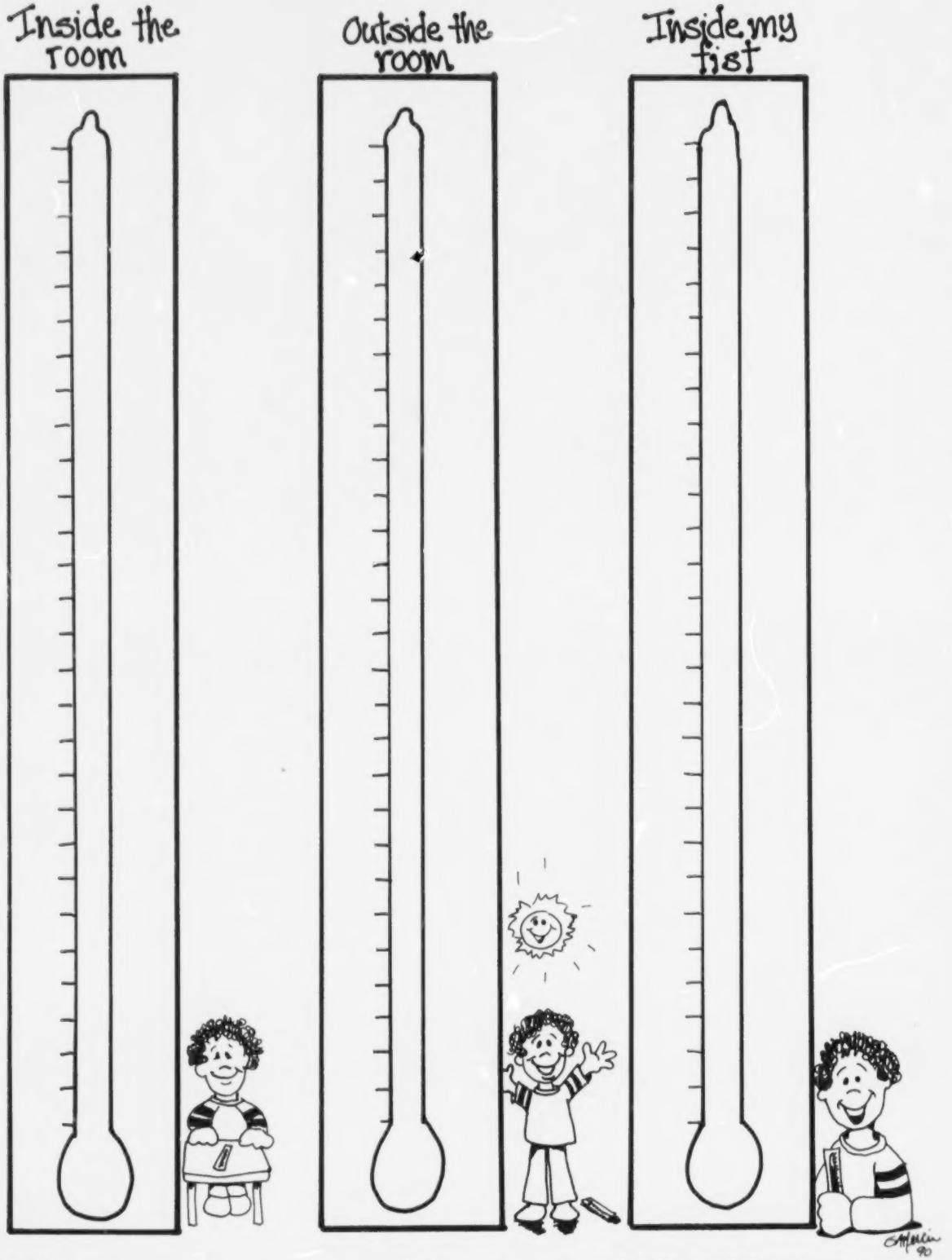
What is the Temperature?



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Primarily Physics

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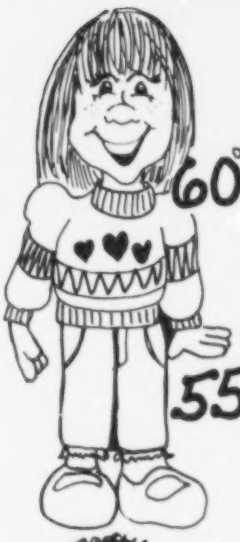

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°F

Fahrenheit

°C

Celsius

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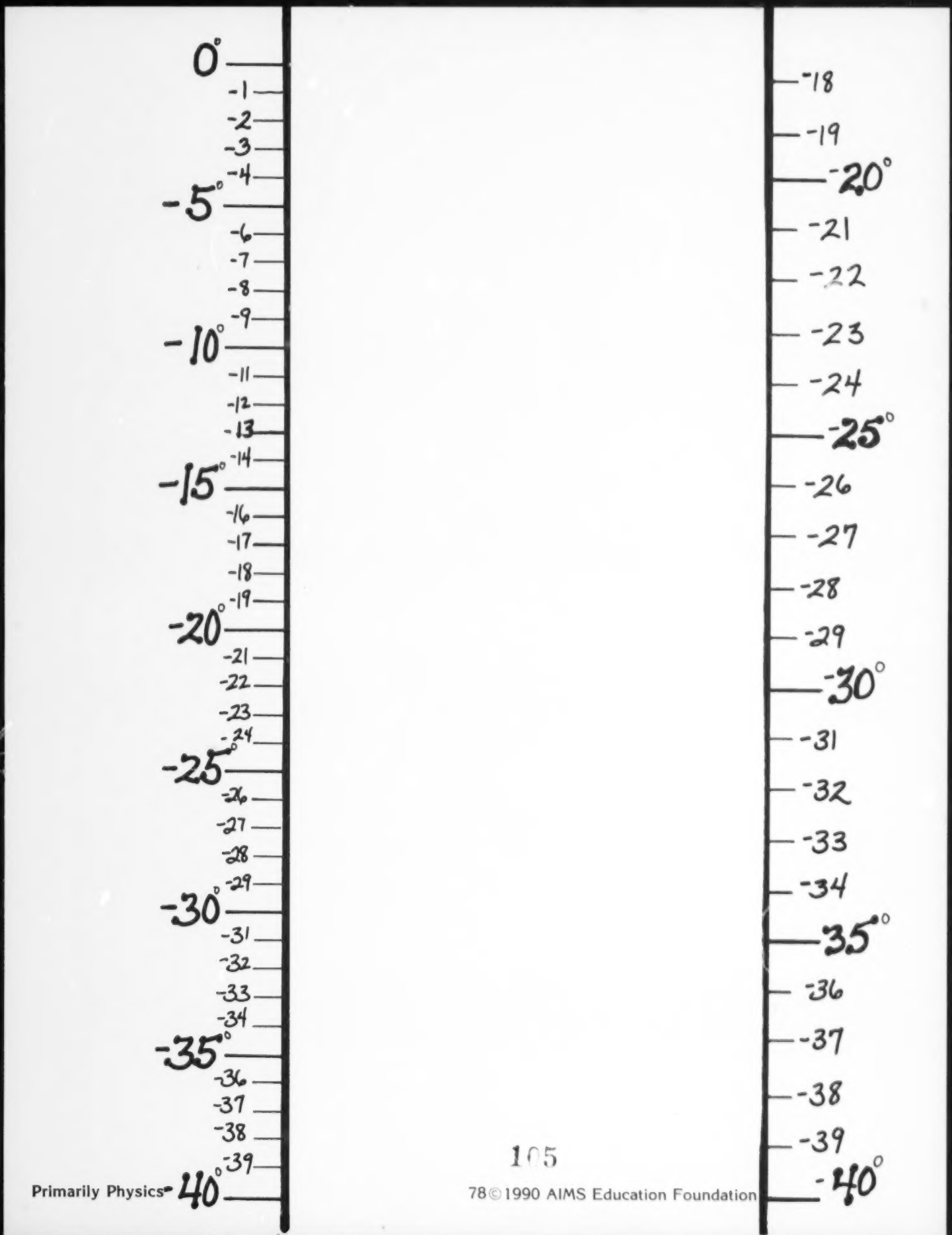

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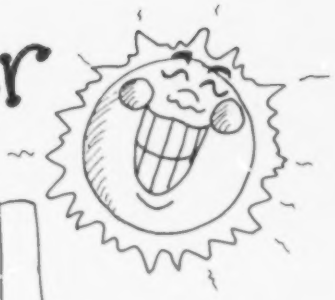
Name _____

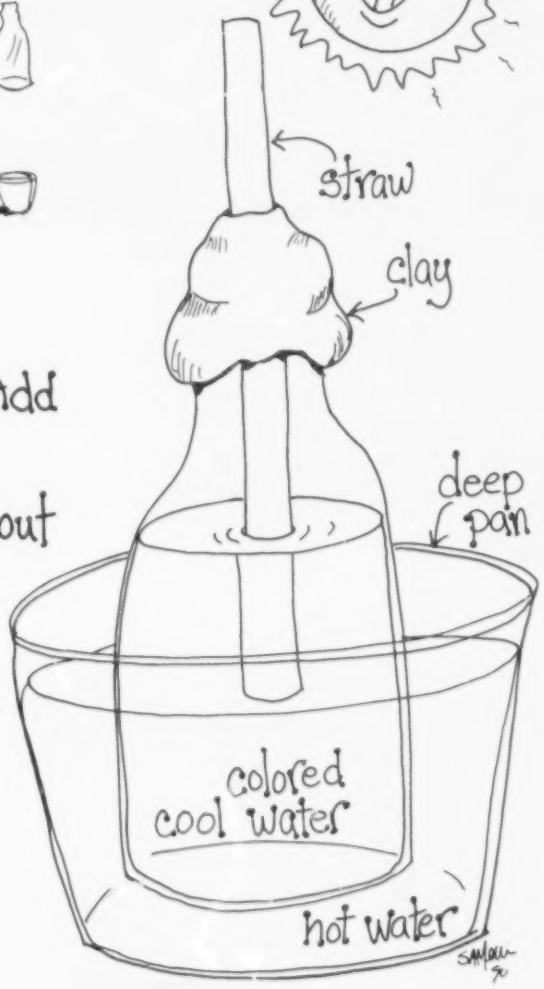
Make a Thermometer



You will need: straw, glass bottle, clay, food coloring, 2 deep pans, hot water, cold water

Do this:

1. Pour cold water into the bottle. Add a few drops of food coloring.
2. Put a straw into the water about halfway.
3. Mold the clay around the top of the bottle. Make a tight seal.
4. Put the bottle into a deep pan.
5. Pour hot tap water into the pan.
6. Watch the water in the straw.
7. Write a sentence about what you see happen.



_____

_____

8. Put the bottle in cold water. What happens?

_____

_____

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Melt an ICE CUBE

I. Topic Area
Physical Science—Heat—Melting an Ice Cube

II. Introductory Statement
The students will discover the fastest way to melt ice and will find the best material to keep ice from melting.

III. Math Skills
Measuring
Comparing
Graphing
Estimating
Problem solving
Timing
Basic computation

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting

IV. Materials
Ice cubes (same size)
Styrofoam cups
Paper
Cloth
Foam rubber
Paper towels
Plastic wrap
Foil
Paper plates

V. Key Question
How fast can an ice cube melt? What is the best insulating material that can be used to keep ice from melting?

VI. Instructional Information
Pure water forms ice at 32° Fahrenheit (0° Celsius). When ice melts, it uses energy. At any temperature higher than 32°F (0°C) ice begins to melt. While the ice is melting, the temperature of the liquid will remain at 32°F (0°C). Heat energy is being used to melt the ice. Once the ice is melted into water, the temperature of the liquid will go up. Heat energy will raise the temperature of the water until it is the same as its surroundings.

Most liquids contract when they freeze, but when water freezes it expands. Water that freezes in cracks in rocks can split them apart.

Pure water freezes at 0°C, but if anything is dissolved in the water the freezing point is lowered. Salt is used in ice cream making machines to melt the ice. When salt is mixed with ice, it lowers the freezing point and the ice melts. However, when ice melts, it needs to take up heat from its surroundings, so it removes the heat from the ice cream mixture, thus freezing it.

VII. Management Suggestions
1. Make equal sized ice cubes the day before.
2. Collect many different materials that the students can use to wrap around the ice cube to keep it from melting.
3. No fire can be used and the ice cube cannot be broken in pieces.

VIII. Procedure
Melting the ice cube
1. Discuss why ice melts. Talk about why we use ice cubes. (to cool drinks) What would happen if we didn't have ice?
2. Have the students predict how long it will take for an ice cube to melt if it is left out on the table.
3. Divide the class into small groups.
4. Tell them the object of the lesson is to see how fast each team can melt its ice cube.
5. Give each group one ice cube (of the same size) in a plastic bag or on a plate.
6. No fire can be used and the ice cube cannot be broken up.
7. Record the time the ice cubes are given to the students. Help them determine how many minutes it took to melt the ice cube completely.
8. Have each group write down what they did to melt their ice cube. Compare the time taken to melt the ice cube of all groups.

Keeping an ice cube
9. Discuss what ways ice is kept from melting. (refrigeration, insulated bags, styrofoam containers) What materials would the students use?
10. Predict how long they can keep their ice cube.
11. Divide the class into new groups or keep the same groups as above.
12. Give each group an ice cube of the same size.
13. The object now is to see what materials are the best insulators to keep an ice cube from melting.

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14. Have different materials available for the students to choose from to wrap their ice cube. Paper, cloth, paper towels, aluminum foil, plastic wrap, styrofoam cup, etc.
15. Record the starting time.
16. Have the students quickly wrap the ice cube in their one chosen material.
17. Every five minutes they should check their ice cube.
18. Help the students determine how long their ice cube has lasted. Compare the time that each group was able to keep their ice cube.

IX. Discussion Questions

Melting the ice cube

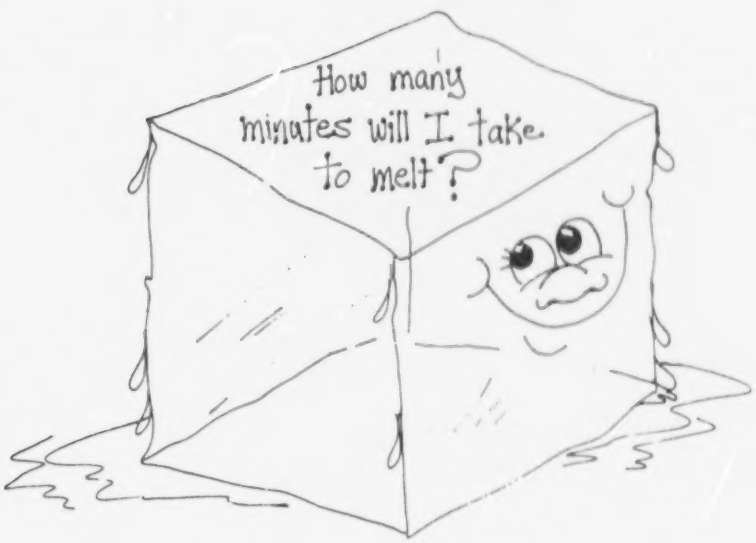
1. What was the shortest time it took to melt the ice cube?
2. What method was used?

Keeping an ice cube

3. How long did the ice cube remain frozen?
4. What method kept the ice the longest?
5. What material was used?

X. Extensions

1. Use different size ice cubes.
2. Make giant "cubes" in plastic ziploc type bags or margarine tubs. Will it melt before school is out?
3. Discuss with the students how ice was obtained and kept before refrigeration (Lake ice was cut in large blocks during the winter and kept in insulated houses or covered with sawdust until used.)
4. Make a chart of the number of minutes to melt and number of minutes kept. List every group's numbers. Write the numbers on cards and post. Put the cards in order, slowest to fastest, or shortest to the longest.
5. Students can make up math problems with the class numbers. Such as: The red group's ice cube lasted 24 minutes and the blue group's lasted 67 minutes. How much longer did the blue group keep their ice cube?
6. Break a cube into small pieces and allow it to melt. How much faster did it melt. Why?



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Melt a Cube

_____
My name.

I think our ice cube will melt in _____ minutes.

Our ice cube melted in _____ minutes.

What did the group do to melt the ice cube?

_____

_____

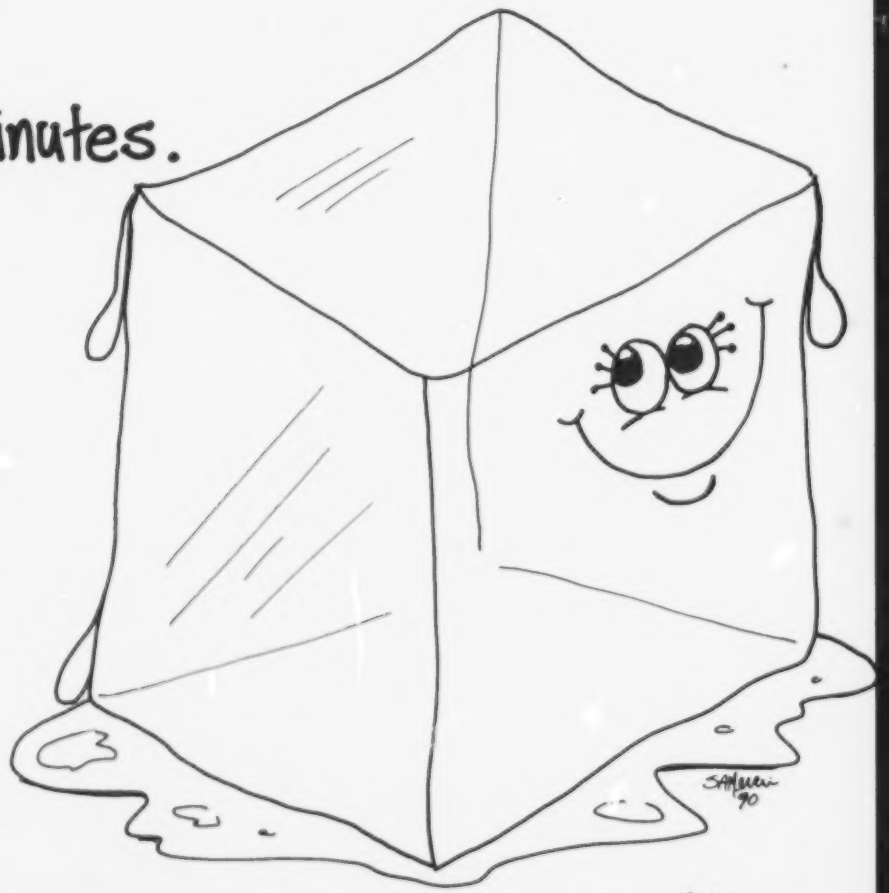
_____

_____

_____

_____

_____



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Keep a Cube

_____
My name

I think our ice cube will last for _____ minutes.

Our ice cube lasted for _____ minutes.

What did the group do to keep the ice cube from melting?

_____

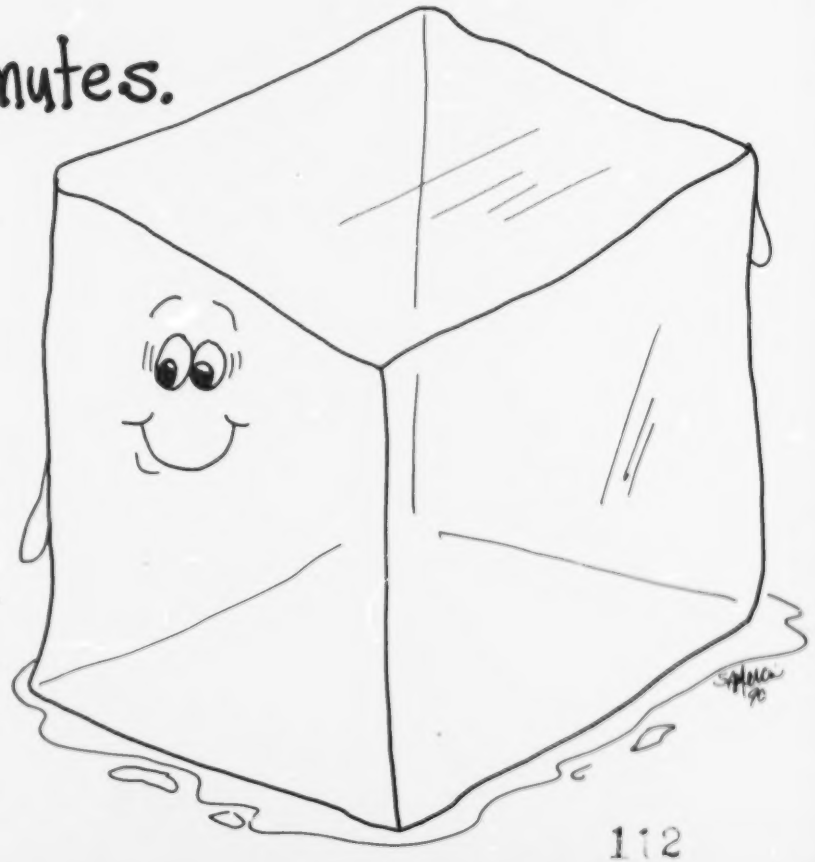
_____

_____

_____

_____

_____



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Heat and Color

I. Topic Area
Physical Science—Heat—Absorption of Heat by Colors

II. Introductory Statement
Students will observe that dark colors absorb heat faster than light colors.

III. Math Skills
Measuring
Comparing
Graphing
Problem solving
Timing

Science Processes
Observing
Communicating
Collecting/Recording data
Drawing conclusions
Interpreting data

IV. Materials
Two white styrofoam cups
Black paint
Two thermometers
Water

V. Key Question
Do dark colors absorb the heat better than light colors?

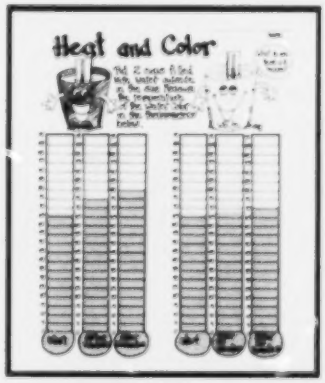
VI. Instructional Information
Black or dark colors absorb the light and change it to heat. Light colors act as reflectors and bounce light off. Light that is absorbed is changed to heat energy. Temperature is the measure of heat energy. The black cups will collect more light energy so that the water temperature inside will rise faster than the water temperature inside the white cups.

VII. Management Suggestions
1. Paint the outside of one styrofoam cup black. (the cup could be covered with black construction paper)
2. Coffee cans can be used, but one can should be covered with black paper and one with white paper.
3. Teachers—before printing student sheet, mark the degrees in Celsius or Fahrenheit.

VIII. Procedure
1. Place two pieces of construction paper, one piece black and one white, in the sun. After a short period let the students feel each piece of paper. Is there a difference in the temperature of the papers? Ask the students why they think the two pieces have different temperatures.
2. Ask the students why it is beneficial to wear light colored clothes in the summer and darker colors in the winter.
3. Take two styrofoam cups. Paint the outside of one of the cups black (or cover with black paper). Leave the other one white. Coffee cans can be used. Cover one with black paper and the other one with white paper.
4. Pour equal amounts of tap water into both cups.
5. Put a thermometer in each cup. Take the temperature of the water in both cups. Record on the worksheet.
6. Put the cups outside in the sunshine for 30 minutes.
7. Take the temperature of the water in each cup again. Record on the worksheet.
8. Leave the cups in the sun for another 30 minutes; again read the temperature and record.

IX. Discussion Questions
1. What is the difference in the temperatures of the two cups?
2. Ask the students if they can explain what happened. (Black or dark colors absorb the light energy from the sun and it is changed to heat. Light colors act as reflectors and bounce light off.)
3. What would happen if the cups had been placed outside in the shade?
4. Would the temperature be different if another color had been used on the cup (green for example)? or if the outside of the cup was covered with aluminum foil?
5. What if you covered the tops of the cups with plastic wrap or a piece of cardboard?

X. Extension
1. Cut squares from 6 to 8 different colors of construction paper. Be sure to include one that is black and one that is white. Put the squares of construction paper in the sun. Leave for 5 minutes, then let the students feel the papers to see if there is a temperature difference. Now place a thermometer under each square of paper and leave for five minutes. Then read the thermometer. Is there a difference in the temperature? Which color registered the highest temperature? Which color the lowest temperature?



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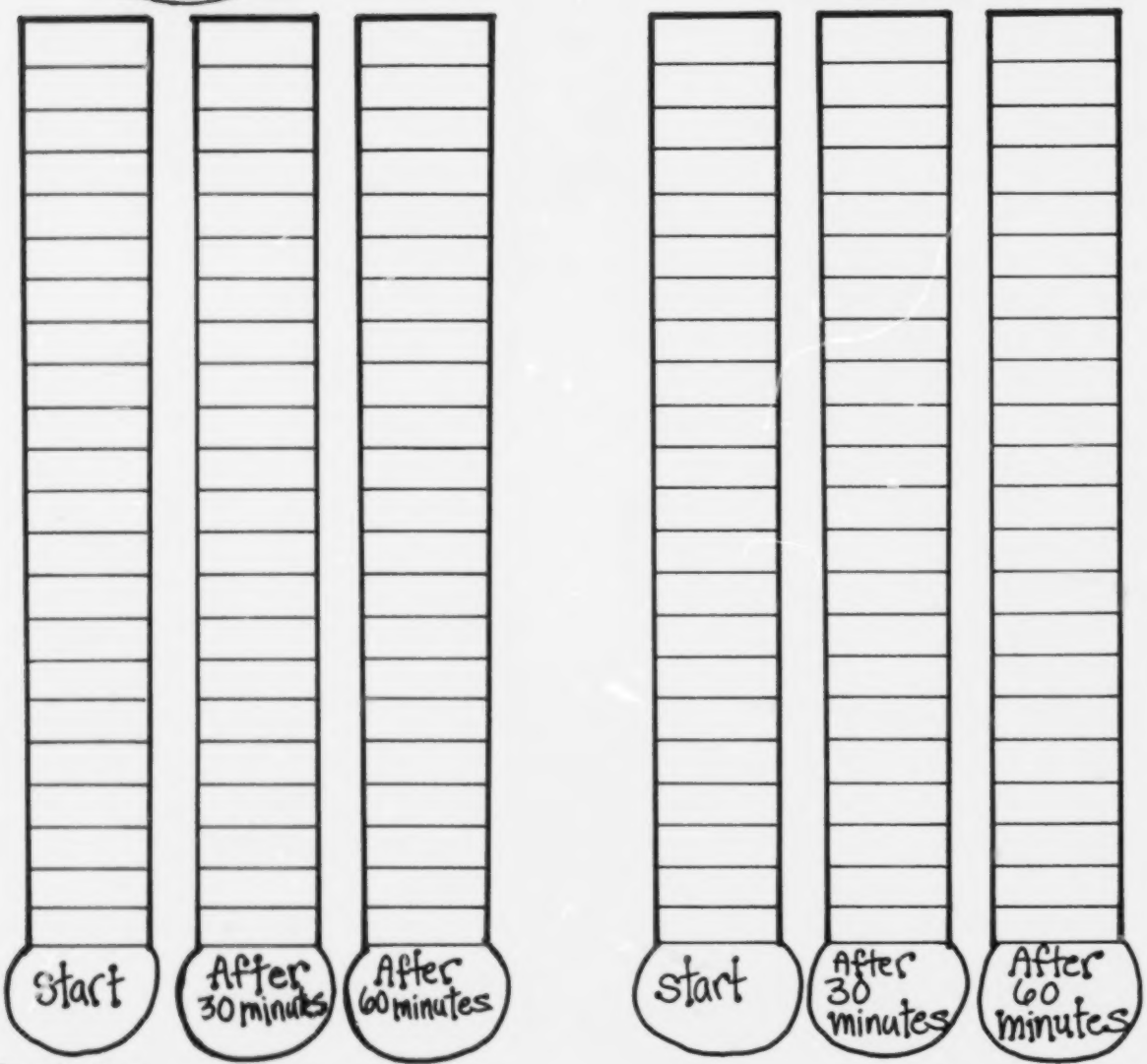
Name _____

Heat and Color

Put 2 cups filled with water outside in the sun. Measure the temperature of the water. Color in the thermometers below.



What did you find out? _____

_____

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When HOT and COLD Meet

I. Topic Area
Physical Science—Hot and Cold Water

II. Introductory Statement
Students will observe hot water moving by convection.

III. Math Skills
Comparing

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing conclusions

IV. Materials
A large jar or small aquarium
2 small bottles or baby food jars
Red and blue food coloring
Hot water
Ice cold water
Room temperature water

V. Key Question
What happens when a small container of colored hot water and a small container of cold water is placed in a large container of room temperature water?

VI. Instructional Information
Heat tends to move from warmer objects to cooler objects. In convection, heat moves by currents of pathways in a fluid. When a fluid such as water is heated it expands or tends to spread out, thus becoming lighter and less dense.

In this activity, the hot colored water in the smaller jar is less dense and lighter than the surrounding cold water. The hot water is buoyed up or pushed upward by the cooler denser water. It rises and resembles smoke pouring from a chimney. The hot colored water tends to rise and then rest along the top or surface of the cooler water. If left long enough and the water is not disturbed, the colored water will then cool and fall to the bottom of the tank. Mixture of the two fluids will occur as their temperatures equalize.

The ice cold water is denser than the surrounding water, so the cold water settles to the bottom of the container. Some students may have experienced a temperature difference in a swimming pool or lake. As they dive toward the bottom, the water is much cooler than the surface water which has been warmed by the sun.

VII. Management Suggestions
1. The teacher may wish to use this as a demonstration and handle the hot water.
2. Use *CAUTION* when handling the hot water.
3. The large container should be filled with room temperature water.
4. The greater the difference in the temperature between the hot and cold water, the more dramatic the experiment will be.
5. When the small bottle of ice cold water is put in the large container, tip it on its side so the cold water can flow out.

VIII. Procedure
1. Fill an aquarium or large jar with room temperature water.
2. Fill the small bottle with hot water and add three drops of red food coloring. Cover the bottle with aluminum foil and put a rubber band around the neck.
3. Gently lower the small bottle into the large jar or aquarium.
4. Puncture the aluminum foil with a pencil point so the colored hot water can flow out. As the jar is put on the bottom of the aquarium and the foil punctured, a fountain of hot water will

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be released. Soon all the red colored water will be floating at the top of the room temperature water. This is because hot water has expanded and is lighter than the cold water so it rises to the top. (If the colored water doesn't flow out, you may have an air bubble trapped under the foil. Put two holes in the aluminum foil.)

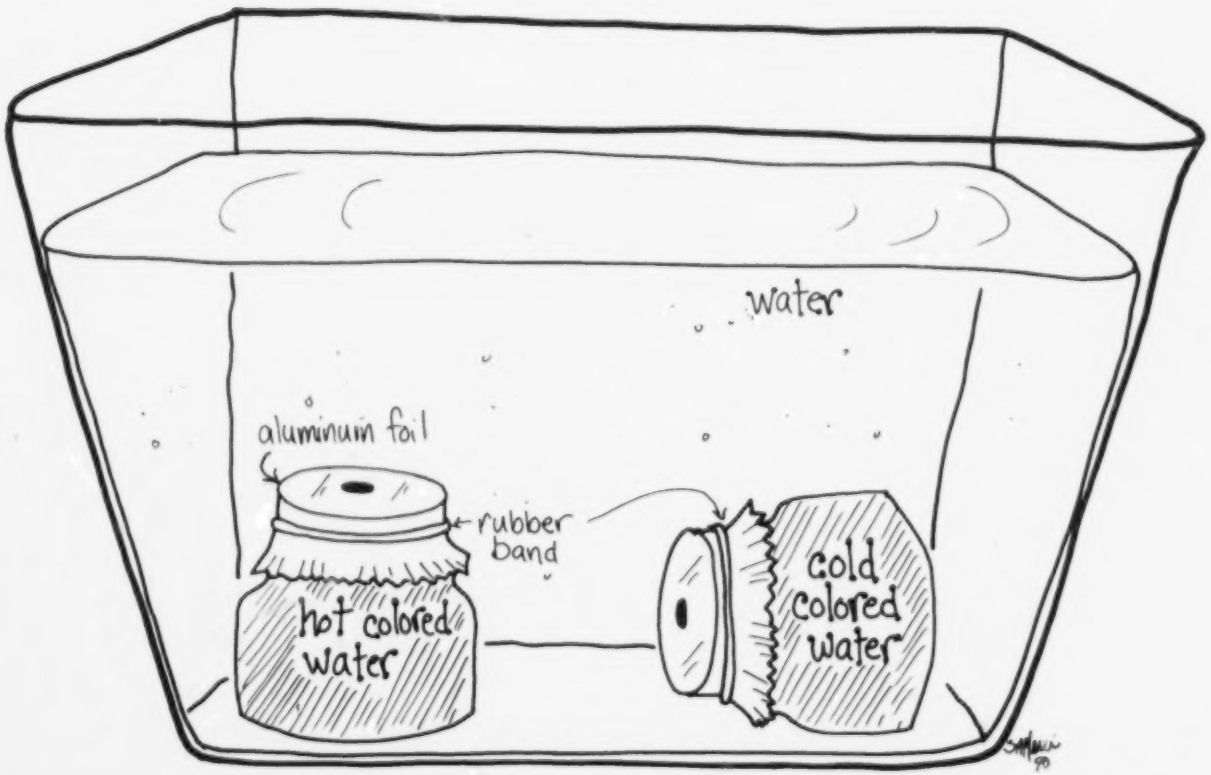
5. Have the students observe what is happening and draw the results on the worksheet.
6. Fill the other small bottle with ice water and add three drops of blue food coloring. Cover the bottle with aluminum foil and put a rubber band around the neck.
7. Gently lower the small bottle into the large container and puncture the aluminum foil. Tip the bottle on its side so the cold water can flow out on the bottom of the container.
8. Have the students observe what is happening and draw the results on the students sheet.
9. Then the students will explain on the bottom of the worksheet what they observed.

IX. Discussion Questions

1. Why does the colored hot water rise to the top of the aquarium and the cold stay on the bottom? (The hot water is lighter and less dense and so rises; the cold water is heavy and sinks to the bottom.)
2. What other material rises as it is heated? (air)
3. What would happen if the colored water in the container was left alone for one hour? (If the water is not disturbed, the hot and cold water will mix as their temperatures equalize and the colors will blend.)

X. Extension

1. Make colored ice cubes by adding food coloring to water, then freezing. As the cube melts, the colored water will stream from the cube to the bottom of the container. Try it!



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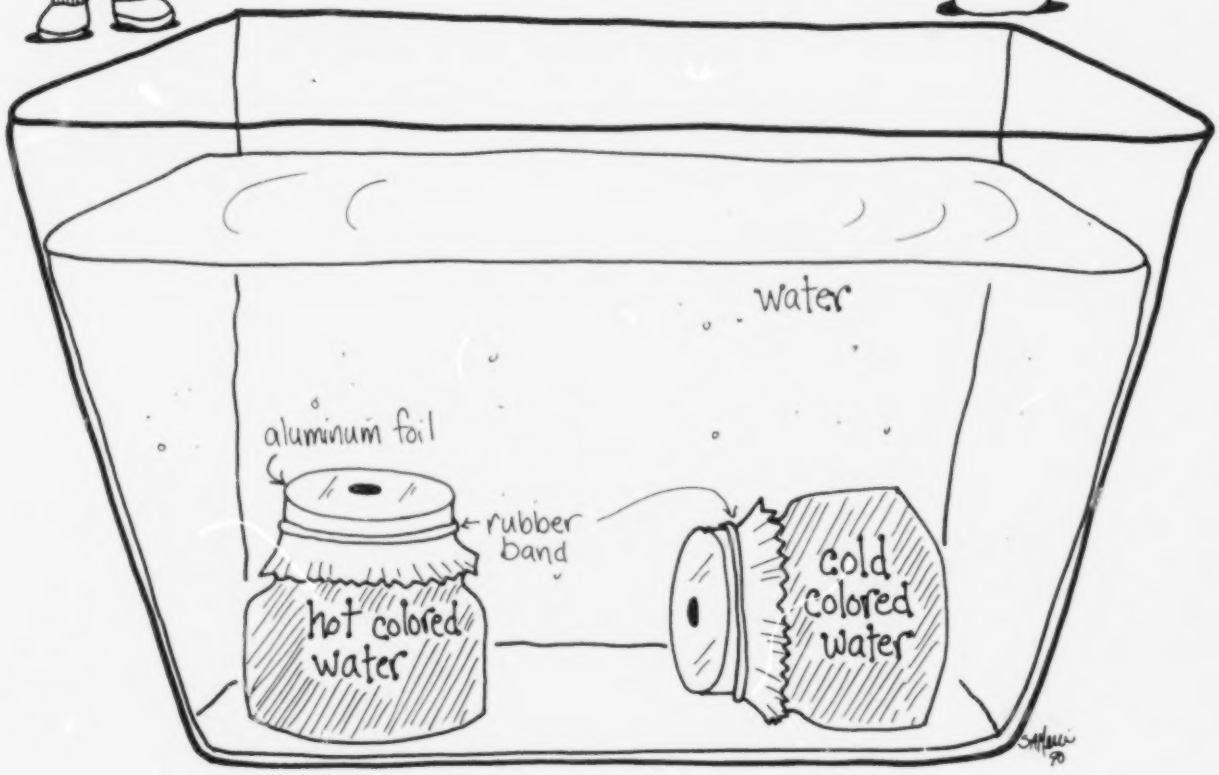
Name: _____

When HOT and COLD Meet

1. Put the bottle of hot colored water into the tank of water. Use a pencil to make a hole in the aluminum foil.

2. Put the bottle of ice colored water into the tank of water. Use a pencil to make a hole in the aluminum foil.



3 Write about what you saw happen. _____

_____

4. Why do you think this happened? _____

_____

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Heat Moves

I. Topic Area
Physical Science—Conduction

II. Introductory Statement
The students will learn that metals are a good conductor of heat and plastic and wood are not.

III. Math Skills
Measuring
Comparing

Science Processes
Observing
Communicating
Collecting/Recording data
Predicting
Drawing conclusions
Interpreting data

IV. Materials
Hot water
Large bowl
Metal spoon
Plastic spoon
Wooden spoon or stick

V. Key Question
Which spoon will get hot the fastest?

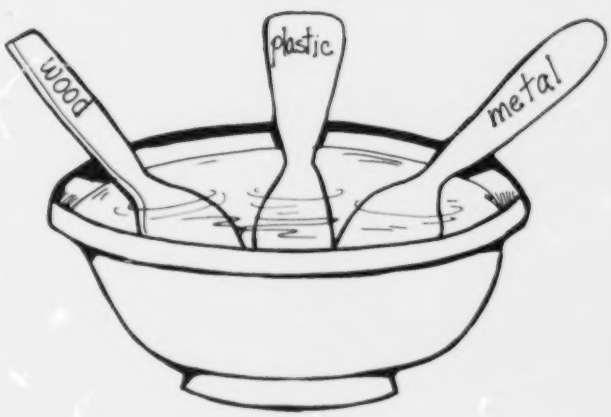
VI. Instructional Information
One way in which heat travels is by conduction. This happens when the fast moving molecules of heated water push the molecules of the metal spoon into motion. Metals are good conductors of heat. Substances that come from living things, like wood, are generally not good conductors and are often used for insulators.

VII. Management Suggestion
1. Get spoons that are about the same size; this will help to make the results more accurate.

VIII. Procedure
1. Ask the students how they think heat moves. Accept all answers; record them on the board.
2. Discuss with the students how handles of metal pans get hot when they are on the heat. What have manufacturers used to insulate the hot handles?
3. Have the students feel each object (the metal spoon, the plastic spoon, and the wooden stick). Rank them from coolest to hottest according to how they feel.
4. Pour hot water into a bowl.
5. Put all three objects into the water. Hold on to the handles of the spoons.
6. Which spoon handle warms up the fastest?
7. Rank the objects again according to how they feel from coolest to hottest. Is the ranking the same as it was before?
8. Introduce the words conductor and insulator. Explain that conductors allow the heat to flow much faster and easier than insulators.

IX. Discussion Questions
1. Why did the metal spoon warm up the fastest? (metals are good conductors of heat)
2. Why was the ranking of the objects probably not the same before they were heated and after?
3. Can you think of other material that does not conduct heat and can be used as an insulator? (Explain that materials that come from living things, like wood, are generally not good conductors and are often used for insulators.)

X. Extension
1. Challenge the student to find other objects that will conduct heat when put into hot water.



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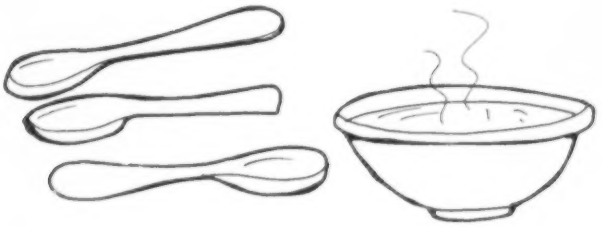
Heat Moves

Name _____

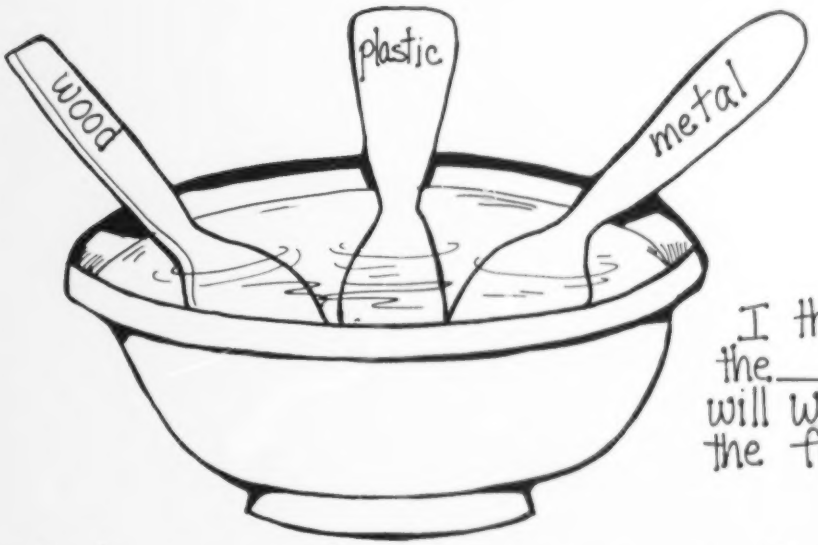
You Will Need:

wooden spoon
plastic spoon
metal spoon
bowl of hot water



Do this:

1. Pour hot water into a bowl.
2. Feel each spoon. They should be the same temperature.
3. Put the three spoons into the water.
4. Hold the handles of the spoons.



I think that the _____ spoon will warm up the fastest.

5. Which spoon handle warms up the fastest?

_____

6. Why do you think this happens?

_____

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Heat Travels

I. Topic Area
Physical Science—Heat Conduction

II. Introductory Statement
The students will learn that metal is a good conductor of heat.

III. Math Skills

Science Processes
Observing
Communicating
Drawing conclusions

IV. Materials
Metal rod (metal knitting needle, clothes hanger, etc.)
Candle wax
Thumbtacks (paper clips or push pins)

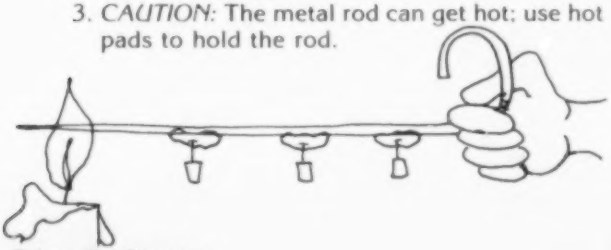
V. Key Question
How does heat travel along a metal rod?

VI. Instructional Information
Heat is transferred from one place to another by conduction, convection, and radiation.

Conduction is a method of heat movement. When the molecules of an object are heated, they begin to vibrate. As the molecules move and collide with adjacent molecules, gradually all the molecules are in motion and heat spreads thoughout the entire object.

Not all objects conduct heat equally well. Wood, plastics, and natural materials are all poor conductors and are often used as pot holders and pan handles. These materials that conduct heat slowly are insulators.

VII. Management Suggestions
1. Use a metal rod, metal knitting needle, or clothes hanger.
2. Fasten pins at intervals along the hanger by dripping candle wax from a burning candle onto the rod and holding the pins in the wax until the wax hardens.
3. *CAUTION:* The metal rod can get hot; use hot pads to hold the rod.



VIII. Procedure
1. Discuss with the students how they think heat travels in metal.
2. Ask if they have ever picked up a pan that has been on a hot element and found the handle hot. How has it gotten hot?
3. To show conduction, heat, with a candle flame, one end of the metal rod that has pins fastened to it by candle wax.
4. Watch the wax and pins carefully.
5. Has something happened to the pins?
6. Is there a pattern to the way the wax melts and drops the pins?

7. How can this be explained?
8. Do the worksheet "Heat Travels". Have the students draw what happened and write what they had observed.

IX. Discussion Questions
1. Which pin drops first? (the one closest to the source of heat)
2. What happens to the wax? (the wax will melt)
3. What has happened to the metal rod? (it has gotten hot)

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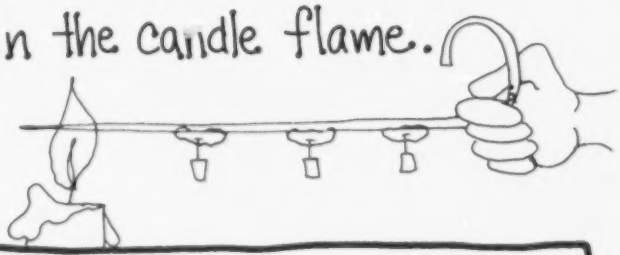
Heat Travels

Name _____

You will need: metal rod (knitting needle, coat hanger)
candle wax
thumb tacks
candle flame

Do This:

1. Use a metal rod that has pins attached by candle wax.
2. Hold the end of the rod in the candle flame.. (Ask an adult to do this)



3. Watch closely.
4. Draw what happened.

5. Write about what you observed. _____

_____

_____

_____

_____

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Cold Tin and Hot Hands

I. Topic Area
Physical Science—Heat—Air Expands

II. Introductory Statement
Students will be able to see that air when heated will expand.

III. Math Skills
Comparing

Science Processes
Observing
Communicating
Collecting/Recording data
Drawing conclusions

IV. Materials
Dishwashing soap
Frozen juice can (or any small metal can with one end removed)
Flat plate

V. Key Question
What happens when air is heated?

VI. Instructional Information
Heat travels by convection; that is, warm air rises and this is called convection. Heat causes molecules to move faster. The faster they move, the hotter the air is. As the molecules heat and move faster, they are moving apart. Because there is more space between the molecules, the air is less dense than the surrounding matter and the hot air floats upward. This is the concept used in hot air balloons. The air is heated by the burner and the expanding air causes the balloon to rise through the denser, cooler air.

When the metal can is dipped in the soap mixture, the soapy water makes a film across the opening. As the children hold the can, their body heat causes the can to heat up. The air inside the can expands and the bubble will "grow" or bulge up over the edge of the can.

VII. Management Suggestions
1. The smaller frozen juice cans work well. A can that is too large has too much air for the children's hands to heat.
2. Let the tin can "cool off" after each use; you will get a better bubble.
3. Put the can in a refrigerator.

VIII. Procedure
1. Make a bubble mixture of some water and a small amount of diswasher detergent.
2. Be sure the frozen juice can is cold. Put it in the refrigerator or freezer if possible.
3. Dip the opening of the juice can in the bubble mixture.
4. Turn the can upright; there should be a bubble film covering the opening.
5. Put your hands around the can and hold tightly.
6. Watch what happens and watch the beautiful colors in the bubble.
7. When the bubble breaks, cool the can and try again. Does the same thing happen again?
8. Record the children's observations on the chalkboard. Use the worksheet and have the students write sentences describing their experiences.

IX. Discussion Questions
1. What happens to the soap film covering the opening of the can?
2. What do you think happens to the air inside the can as it warms? (it expands)
3. Do you think you would have the same results with a larger diameter tin can? (probably not)
4. Would the same thing happen if the small can was warm when the experiment was started?

X. Extensions
1. Pour a small amount of water into a flask. Put a large balloon over the mouth of the flask. Heat the water and watch the air in the balloon expand.
2. Have the children name the colors that they see in the soap bubble and describe how the colors move across the film. Use watercolors to paint bubbly swirly colors on 12" x 18" art paper. After the paintings are dry, they could be folded and used as a folder for papers.

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Name _____

Cold Tin and Hot Hands

1. Use an ice cold can.
2. Dip the top of the tin can in the bubble juice.

3. Hold the tin can with both hands and watch the bubble.
4. Write about what happened.

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GLOSSARY

absorb—to retain wholly, without reflection or transmission what is taken in

auditory nerve—a sensory nerve consisting of the cochlea, that conveys sound to the brain; and the semi-circular canal, that carries impulses involved in maintaining equilibrium.

aurora borealis—a brilliant display of flashing lights in the northern night sky believed to result from electrically charged particles from the sun.

buoyancy—the upward force exerted by a fluid on a body immersed in it

cartilage—a tough elastic connective tissue attached to the surface of bones near the joints

celsius—the temperature scale on which the freezing point of water is 0° and the boiling point is 100°

cochlea—a spiral tube in the inner ear resembling a snail shell and having nerve endings that transmit sound impulses along the auditory nerve.

concentric—having the same center

conduction—the transmission of heat by the transferring of energy from one particle to another

convex—curved or rounded outward like the outer surface of a ball

cornea—the transparent membrane covering the iris and the pupil of the eyeball

echolocation—the process of finding range and direction of objects by the sounds reflected from them

energy—the capacity or power for doing work or making things move

fahrenheit—the temperature scale on which the freezing point of water is 32° and the boiling point is 212°

friction—resistance to motion of surfaces that touch

insulate—to keep from losing heat or sound by covering, packing or surrounding with a nonconducting material

iris—the colored part around the pupil of the eye. The iris controls the amount of light entering the eye

larynx—the upper end of the human windpipe, containing the vocal cords and acting as an organ of voice

magnifying glass—a lens or combination of lenses that causes close objects to appear larger

membrane—a thin, soft, pliable sheet of tissue covering some part of the organism

molecule—the smallest particle into which an element or compound can be divided without changing its chemical or physical properties

opaque—impervious to the passage of light

optic nerve—a nerve connecting the nerve cells of the retina with the brain

organ—any part of animal or plant that is composed of various tissues organized to perform some particular function. The eyes, stomach, heart, and lungs are organs of the body

pitch—the characteristic of sound that depends on the frequency of vibrations of the sound waves. High pitched sounds have higher frequencies than low pitched sounds

rarefaction—a decrease in density and pressure in air due to the passing of a sound wave

reflection—the turning back of a ray of light falling upon a surface

refraction—the turning or bending of a ray of light when passing obliquely from one medium into another of different density

retina—the structure in the eyeball that is sensitive to light and receives optical images

sclera—the tough, white outer membrane which covers the eyeball

translucent—a material that admits and diffuses light so that objects beyond cannot be clearly perceived.

transparent—capable of transmitting light so that objects and images beyond can be clearly seen

vibrate—to move back and forth rapidly

vocal cords—the lower of two pairs of bands or folds in the larynx that vibrate when drawn together and when air is passed up from the lungs, thereby producing vocal sounds

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